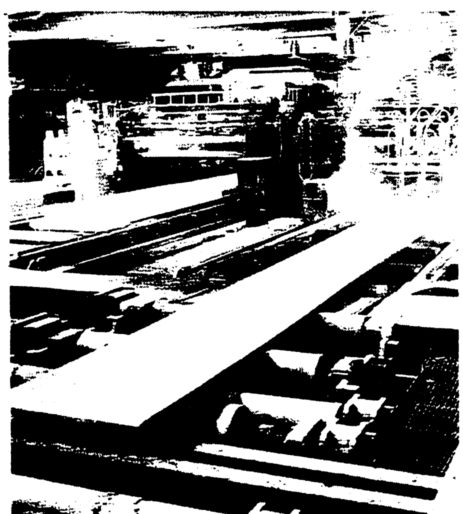
Steel Industry Annual Report

On Competitive Conditions In The Steel Industry And Industry Efforts To Adjust And Modernize

Report to the President on
Investigation No. 332-289
Under Section 332 of the
Tariff Act of 1930



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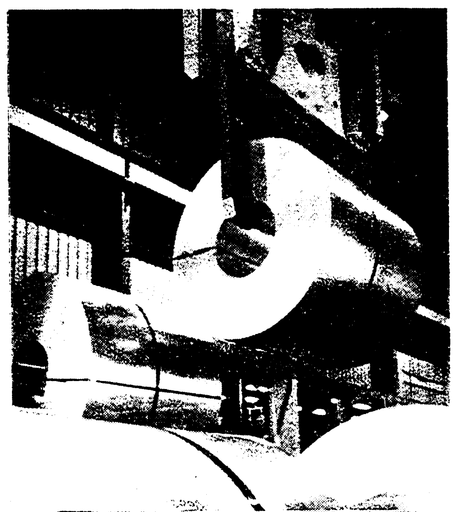

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1. Continuous casting advances have helped lower minimum efficient scale for producing steel products.
2. Steel coils meet increasingly demanding specifications for flatness, formability, and surface finish.
3. Computerized controls improve efficiency and product quality at steel mills.
4. Steelworker oversees operation of galvanizing line, where U.S. producers have focused much of their investment.

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COMMISSIONERS

Anne E. Brunsdale, Acting Chairman

Seeley G. Lodwick

David B. Rohr

Don E. Newquist

Office of Industries
Robert A. Rogowsky, Director

This report was prepared principally by

Richard Brown, Project Leader
Hugh Arce
Laszlo Boszormenyi
James Brandon
Ariel Dybner
Robert Feinberg
Nancy Fulcher
Sharon Greenfield
Stephanie Kaplan
Kathy Lahey
Karen Laney-Cummings
Robert Mascola
Mark Paulson
Anna Mae Toth
Marshall Wade
Charles Yost

under the direction of

Larry Brookhart, Division Chief
Peter Avery, Branch Chief

Minerals and Metals Division

Address all communications to
Kenneth R. Mason, Secretary to the Commission
United States International Trade Commission
Washington, DC 20436

NOTE

The whole of the Commission's report to the President may not be made public since it contains certain information that has been classified by the United States Trade Representative or would result in the disclosure of the operations of individual concerns. This published report is the same as the report to the President, except that the above-mentioned information has been omitted (as indicated by asterisks) or combined with data from related product categories to ensure confidentiality.

The information and analysis in this report are for the purpose of this report only. Nothing in this report should be construed to indicate how the Commission would find in an investigation conducted under other statutory authority covering the same or similar matter.

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EXECUTIVE SUMMARY

This report examines (1) international competitive conditions; (2) current conditions in the U.S. steel industry; and (3) efforts by the major companies to adjust and modernize. The analysis focuses principally on the segments of the industry that produce carbon steel products. These segments account for over 95 percent of U.S. steel production.

International Competitive Conditions

The initial chapters of this report assess changes that have occurred in competitive conditions in steel, focusing on the implications for U.S. producers.

The examination of consumption, production, and trade patterns in chapter 2 indicates that the global and domestic industries have been, and will likely continue to be, affected by:

- diminished geographic concentration of global consumption and production of steel, reflecting the growing importance of steel in nonindustrialized countries;
- diminished consumption of steel in industrialized countries due to the reduced role of steel-consuming industries and decreased intensity of steel use;
- global adjustment efforts, which, by reducing excess capacity, have improved the economic climate for steel; and
- increased competition from alternate materials, particularly in automotive applications, although displacement of steel has not occurred to the extent projected by many auto and auto-supplying industry experts.

In chapter 3, an assessment of the changes in the competitive environment reveals that:

- foreign investment, particularly in the United States, has provided and will likely continue to provide capital and technology for the modernization of existing operations and construction of new facilities;
- the U.S. industry as a whole continues to lag behind many of its principal competitors in terms of installed production technology and capital spending;
- by decreasing labor input requirements, increased automation of steel mills has reduced the traditional U.S. competitive disadvantage in labor costs resulting from relatively high wage rates;
- U.S. minimills have been in the forefront of incorporating technologies that make small scale production commercially viable over more product lines;
- foreign government commitment to reduce state ownership, financial assistance, and trade-distorting measures could create a significantly more equitable competitive environment, to the benefit of the U.S. industry; and
- national environmental standards for air and water pollution do not seem to create a competitive disadvantage for U.S. producers since other industrialized countries have adopted similar laws, although more stringent U.S. standards in waste definition and disposal may require greater spending by U.S. producers.

The international competitiveness of the U.S. industry in terms of price, quality, and service, as discussed in chapter 4, can be summarized as:

- strong in terms of costs, but highly sensitive to exchange rates;
- improved in terms of meeting more demanding product quality specifications, but still lagging behind Japanese producers in terms of overall product quality; and

- improved and comparable to Japanese producers in terms of meeting increasingly demanding service requirements.

Chapter 5 concludes that the competitive outlook of the domestic industry varies by segment and, specifically, that:

- success of the major integrated producers depends on their ability to differentiate their products in terms of quality and support services provided to customers;
- the major producers remain vulnerable to competition from substitute materials, competition from minimills and smaller integrated mills, and declines in consumption in the high value, flat-rolled market;
- the success of smaller integrated mills, which focus on undifferentiated products, depends on their ability to maintain low costs, making them vulnerable to competition from minimills as well as to imports from a wide range of countries;
- minimills remain in a strong competitive position vis a vis foreign producers, given their low production costs, while their competitive position with respect to domestic integrated producers depends on the price of scrap and their ability to overcome technological barriers to compete in flat-rolled sheet products; and
- the role of converters, who purchase partially advanced steel for further processing, seems likely to increase either through investment in new or existing facilities (including joint ventures), or as a result of the maintenance of rolling mills at facilities where raw steelmaking capacity is closed for economic or environmental reasons.

Current Industry Conditions

The analysis of conditions in the domestic industry in chapter 6 indicates that:

- declining prices negatively affected the steel industry's financial performance in 1990 and, combined with declining sales in the first quarter, 1991, contributed to sizeable losses by integrated mills and to declining profit margins in nonintegrated sectors;
- the import penetration and exports-to-shipment ratios increased from 1989 levels, registering 19.6 and 7.8 percent respectively for the first five months of 1991; and
- employment continued its decade-long decline, falling by 2.5 percent, to 271,000 workers in 1990.

Major Company Efforts to Adjust

Chapter 7 provides information to the President on whether conditions set by Congress in its authorizing legislation for the VRAs have been met. The data indicate that:

- collective expenditures of major integrated companies on steel plant and equipment from October 1, 1990, to May 31, 1991, exceeded net cash flow from steel operations; forecasts for the June 1, 1990, to September 30, 1991, period indicate that the same will be true for the entire 12-month period ending September 30;
- each major company's expenditures on worker retraining exceeded 1 percent of adjusted net cash flow (for the companies whose cash flow was positive), and forecasts show the conditions will hold for the 12-month period ending September 30; and indicate that
- major companies have continued their efforts to improve competitiveness, primarily by upgrading their abilities to produce high value sheet products and by closing uncompetitive facilities.

CHAPTER 1
INTRODUCTION

Purpose And Scope Of Study

On March 16, 1990, the United States International Trade Commission instituted investigation No. 332-289, *Steel Industry: Annual Report on Competitive Conditions in the Industry and Industry Efforts to Adjust and Modernize.* The investigation, conducted in accordance with section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332 (g)), is in response to a request from the United States Trade Representative (USTR) for two annual reports, to be submitted by August 1, 1990, and August 1, 1991, respectively (appendix A). Notice of the investigation was given by posting copies of the notice of investigation at the Office of the Secretary, U.S. International Trade Commission and by publishing the notice in the *Federal Register* of March 22, 1990. See appendix B for a copy of the notice.

This report is the second of two that were requested. The purpose of the report is threefold:

- to assess changes that have occurred in competitive conditions internationally, with particular attention to the position of the U.S. steel industry;
- to analyze current conditions in the U.S. industry; and
- to assess major companies' efforts to adjust and modernize.

The assessment of international competitive conditions includes, among other things, information concerning (1) a historical perspective on the issues affecting present and likely future developments; (2) key factors affecting the competitive environment; and (3) the competitive position of the U.S. steel industry in terms of price, quality, and service. While some comments on the specialty steel industry (i.e., producers of stainless and tool steels) are included, the report primarily addresses the segments of the industry that focus on carbon steel products.

The analysis of current conditions includes information on recent developments in steel consumption, trade, capacity, production, capital expenditures, spending on research and development, employment, and financial performance.

The assessment of adjustment measures taken by major companies includes cash flow information for nine major U.S. companies for the 12-month period ending September 30, 1991, related to the President's annual determination regarding the continuation of the program of Voluntary Restraint Agreements (VRAs); details on this determination are provided in chapter 7. This information includes (1) commitments to worker retraining; (2) executive compensation; (3) the extent to which companies have committed net cash flow to reinvestment in, and modernization of, the steel industry; and (4) efforts taken by the companies to enhance their international competitiveness.

Background of the VRAs

In January 1984, Bethlehem Steel Corporation and the United Steelworkers of America jointly filed a petition with the U.S. International Trade Commission under section 201 of the Trade Act of 1974 (the Act) seeking relief from increased imports of carbon and alloy steel products. In accordance with the Act, the U.S. International Trade Commission conducted an investigation, finding affirmatively in five of nine product areas.[1] The President, however, determining that relief under section 201 was not in the national economic interest, established, under other authority, a nine-point policy to address the concerns of the industry. Accordingly, the President directed the United States Trade Representative to negotiate voluntary restraint arrangements (VRAs) to cover a 5-year period (from October 1, 1984, through September 30, 1989) with countries "whose exports to the United States had increased significantly in previous years."[2] VRAs were eventually concluded with 20 entities.[3]

Although the structure of the arrangements varied among countries, each involved an agreement by the foreign government to limit exports of steel products to the United States. To bring the agreements into effect, U.S. producers withdrew pending unfair trade petitions, and the U.S. Government suspended antidumping and countervailing duties that were in effect on steel products covered by the VRAs. The trade measures were expected to return the share of imports in the U.S. market to a level of approximately 18.5 percent, excluding semifinished steel, which subsequent Administration statements indicated would be limited to about 1.7 million tons per year.

Extension of the VRAs

On July 25, 1989, the President announced the Steel Trade Liberalization Program, under which the VRAs were extended for two and one-half years, terminating on March 31, 1992. The President directed the United States Trade Representative to negotiate VRAs at an overall restraint level of 18.4 percent of

[1] Affirmative decisions were rendered in the case of semifinished steel, plates, sheets and strip, wire and wire products, and structural shapes and units. Negative determinations were rendered in the case of wire rod, railway type products, bars, and pipes and tubes.

[2] See 49 *Federal Register,* p. 36813.

[3] Countries or regions concluding VRAs with the United States included Australia, Austria, Brazil, Czechoslovakia, East Germany, the European Community, Finland, Hungary, Japan, Korea, Mexico, Peoples Republic of China, Poland, Portugal, Romania, South Africa, Spain, Trinidad and Tobago, Venezuela, and Yugoslavia. Portugal's and Spain's VRAs were included in the EC agreement which extended the VRAs through March 31, 1992.

domestic steel consumption (the 1988 import penetration level for VRA countries). In order both to provide incentives for countries to eliminate trade-distorting practices and to respond to concerns of steel consumers for adequate supplies of raw materials, the President authorized additional import penetration up to 1 percent annually, available to countries that entered into bilateral consensus agreements.

On December 12, 1989, the United States Trade Representative announced that negotiations had been completed with the European Community and 16 countries that were previous signatories of VRAs.[4] As a result of the negotiations, the restraint levels for steel mill products (including semifinished steel) increased to 19.1 percent of domestic consumption in the first period of the extended VRA program. Additional increases in restraint levels were authorized for the subsequent period for countries that entered into bilateral consensus agreements.[5] Product coverage under the VRAs remains essentially unchanged, although some agreements were modified to include specialty steel products previously subject to relief under section 203 of the Trade Act of 1974.

Organization And Methodology

Chapter 2 of this report provides a brief introduction to steelmaking processes, the structure of the industry, and an analysis of international market and industry developments since 1970. Chapter 3 identifies and discusses several factors that significantly affected the competitive environment during 1970-91 and are likely to continue influencing events in the international steel industry. These factors are globalization, or internationalization, of the industry, government policy, environmental regulation, technology, and exchange rate variability.

Chapter 4 provides a competitive assessment which describes the present position of U.S. steelmakers in terms of the price and quality of their products and the customer service they offer. Likely changes in the competitive position of the U.S. industry are examined in chapter 5 in light of its present position and the interplay of the factors discussed in the preceding chapters. Chapter 6 provides an analysis of current conditions in the U.S. market and the U.S. industry. Chapter 7 focuses on major company efforts to adjust and modernize.

The Commission developed data and information from interviews with foreign and domestic industry executives, independent analysts, government officials, and from discussions with staff from international organizations. The report also includes data developed from secondary sources and questionnaires sent to 227 producers and 221 purchasers of those steel mill products covered by the voluntary restraint agreements (VRAs). Responses were received from 162 producers, which account for virtually all raw steel production (over 95 percent) and a substantial percentage of steel converters (i.e., companies which process semifinished steel such as slabs and wire rods into sheets and wire). Purchasers who responded to the questionnaires accounted for 35.5 million tons of steel purchases, including 9.8 million tons from steel converters and 25.7 million tons from distributors and end users. The distributors and end users accounted for 4.1 million tons and 21.5 million tons of purchases, respectively.

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[4] The VRA with South Africa was not renewed as most steel imports were under embargo.

[5] Countries or regions with which the United States has negotiated bilateral agreements are the European Community, Japan, Korea, Brazil, Mexico, Australia, Trinidad and Tobago, Austria, Finland, and Yugoslavia.

CHAPTER 2
GLOBAL STEEL INDUSTRY EXPERIENCE, 1970-1991[1]

This chapter begins with an introduction to steel producers and the process of making steel. It then provides basic information on the structure of the steel industry and examines major developments since 1970, with a special focus on the United States. Included are discussions of supply and consumption patterns, trade, employment, and financial performance. Certain topics that are alluded to in this chapter, such as globalization, government policy, technology, and exchange rates, will be discussed more completely in chapter 3.

[1] For the purposes of this report, the term industrialized or developed world refers to the following countries: the United States, Canada, Japan, South Africa, Australia, New Zealand and the countries of Western Europe including Yugoslavia. Centrally planned economy (CPE) countries include the Soviet Union, the Peoples Republic of China, North Korea, Cuba, and the countries of Central and Eastern Europe. The developing world encompasses the remaining counties, i.e. Latin America (excluding Cuba), Africa, the Middle East, and the remaining Asian countries. The term Western world refers to both industrialized and developing nations. In addition, the distinction between East and West Germany is maintained throughout the report.

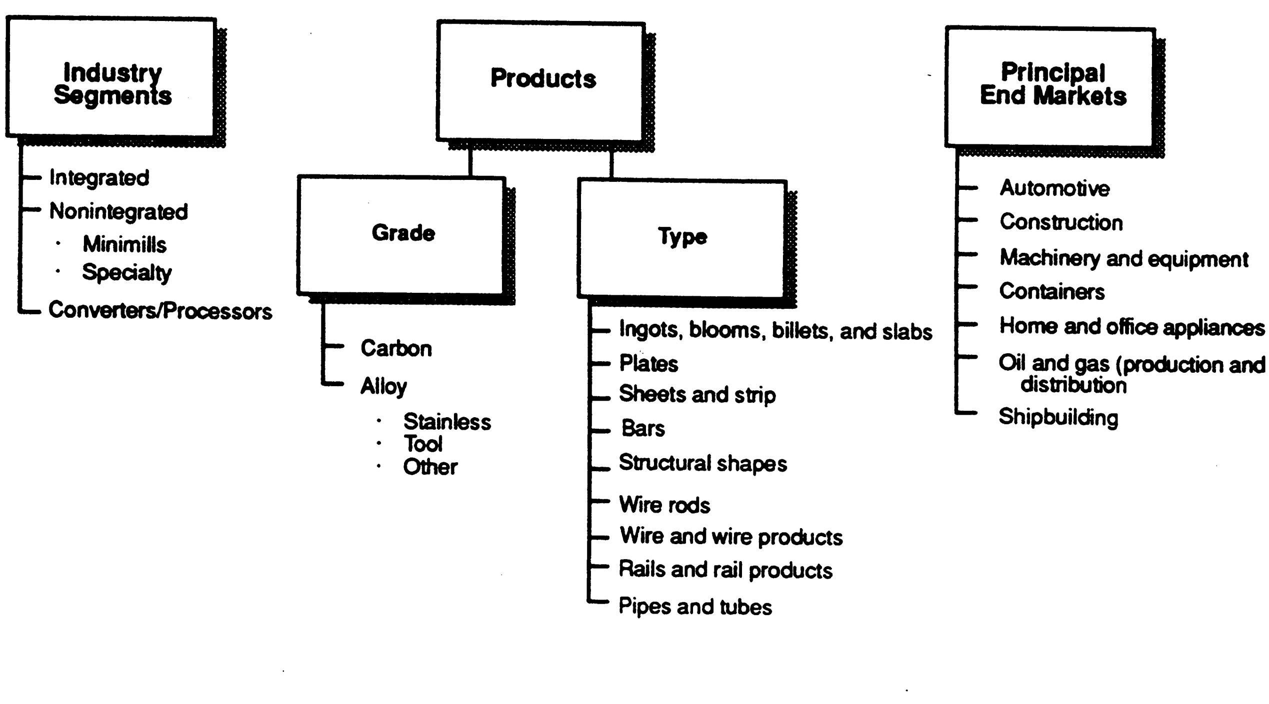
Steel Producers and the Process of Making Steel

Types of Steelmakers

The steel industry consists of integrated mills, minimills, specialty mills, and converters (figure 2-1). Integrated mills are relatively large capital-intensive facilities that produce steel from basic, naturally occurring raw materials such as iron ore, coal, and lime. Facilities vary significantly in size, ranging from those that produce one million tons of steel per year to those capable of producing over 10 million tons. The range of products produced by integrated plants is broad, although most products are carbon steels. Nearly three quarters of the world's steel is produced by integrated facilities.

Nonintegrated facilities produce steel by melting recycled scrap metal in electric arc furnaces (EAF). This method of steelmaking generally involves less up-front investment and lower operating costs. Nonintegrated producers include minimills, a term used to characterize companies that focus on carbon steel products, and specialty steel mills that generally focus on production of higher value stainless and alloy tool steels. Minimills have traditionally produced merchant grade bars, rods, rails and light structural shapes, called "long products". However, in recent years, new technology has expanded the range of products that

Figure 2–1
Steel industry overview



minimills can economically produce; a number of mills now produce products such as sheet and wide flange beams, formerly produced almost exclusively by integrated producers. Minimills are generally smaller than integrated mills, typically producing much less than 1 million metric tons of raw steel per year at any one facility.

Like minimills, specialty steel companies produce steel by melting scrap in an electric arc furnace and are smaller than integrated companies. Stainless and alloy steels are made by adding a variety of alloys, such as chromium, nickel, and molybdenum, to the liquid steel to impart specific properties to finished steel products. Specialty steel mill products are used in a variety of applications, including automobiles, food-processing equipment, medical instruments, and household flatware.

Steel converters (or processors) do not produce molten steel, but instead purchase steel for further processing. Common converting operations include the production of bars from purchased billets, wire from wire rod, pipes and tubes from skelp (plate), and coated products from cold-rolled steel.

Steelmaking Processes

As discussed above, steel is produced either by the integrated or nonintegrated process (figure 2-2). The nonintegrated process produces molten steel by melting steel scrap in an EAF. Integrated producers, on the other hand, smelt processed iron ore and coke in a blast furnace to produce molten iron ("pig iron"), which is subsequently poured into a steelmaking furnace, generally a basic oxygen furnace (BOF), together with scrap. The hot metal is processed into steel when oxygen is blown into the metal bath. Lime is added to serve as a fluxing agent; it combines with impurities (oxidized carbon and other elements) to form a floating layer of slag, which is later removed.

Whether produced by the integrated or nonintegrated process, it is increasingly common for molten steel to pass through a ladle metallurgy station, where its chemistry is refined to embody the steel with properties required for specific applications. At the ladle metallurgy, or secondary steelmaking, station, such elements as oxygen and oxides, sulfur and sulfides, hydrogen, and carbon are removed while the temperature of the steel is adjusted for optimum casting. Meanwhile, the primary steelmaking vessel (electric arc furnace or basic oxygen furnace) may be charged with new materials to begin another refining process.

Once molten steel with the correct properties has been produced, it is cast into a form that can enter the rolling process (figure 2-3). Currently the industry uses two principal methods of casting: ingot teeming and continuous casting. Ingot teeming is the traditional process in which steel is poured into individual molds, allowed to solidify, and then separated from the molds. The steel ingots are then placed in soaking pits where they are heated until they reach a uniform temperature. The reheated ingots are then ready to be processed, or rolled, into semifinished shapes.

Figure 2–2
Simplified steelmaking flowchart

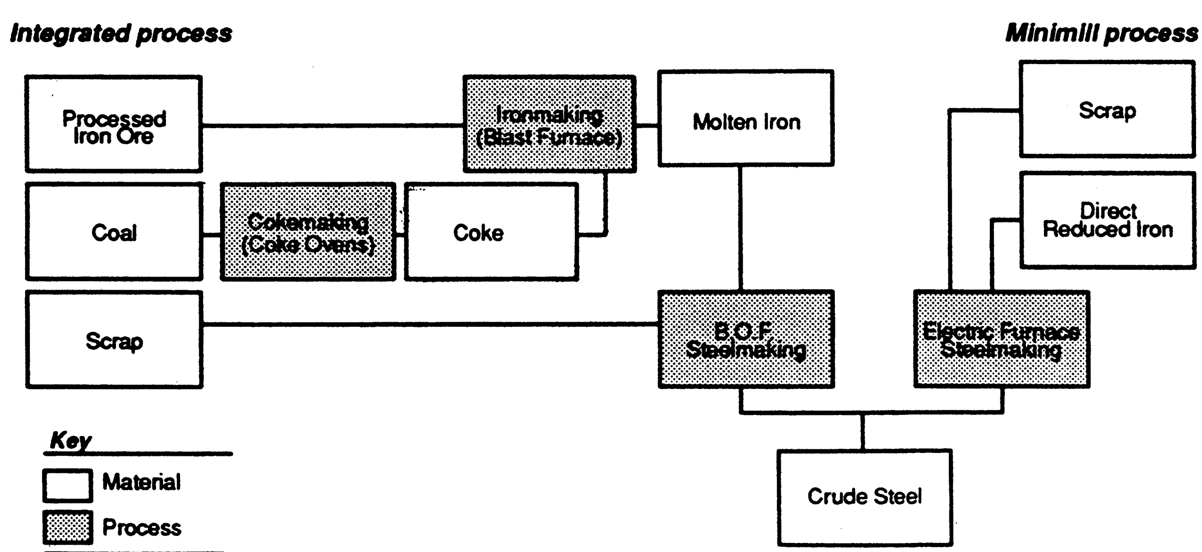
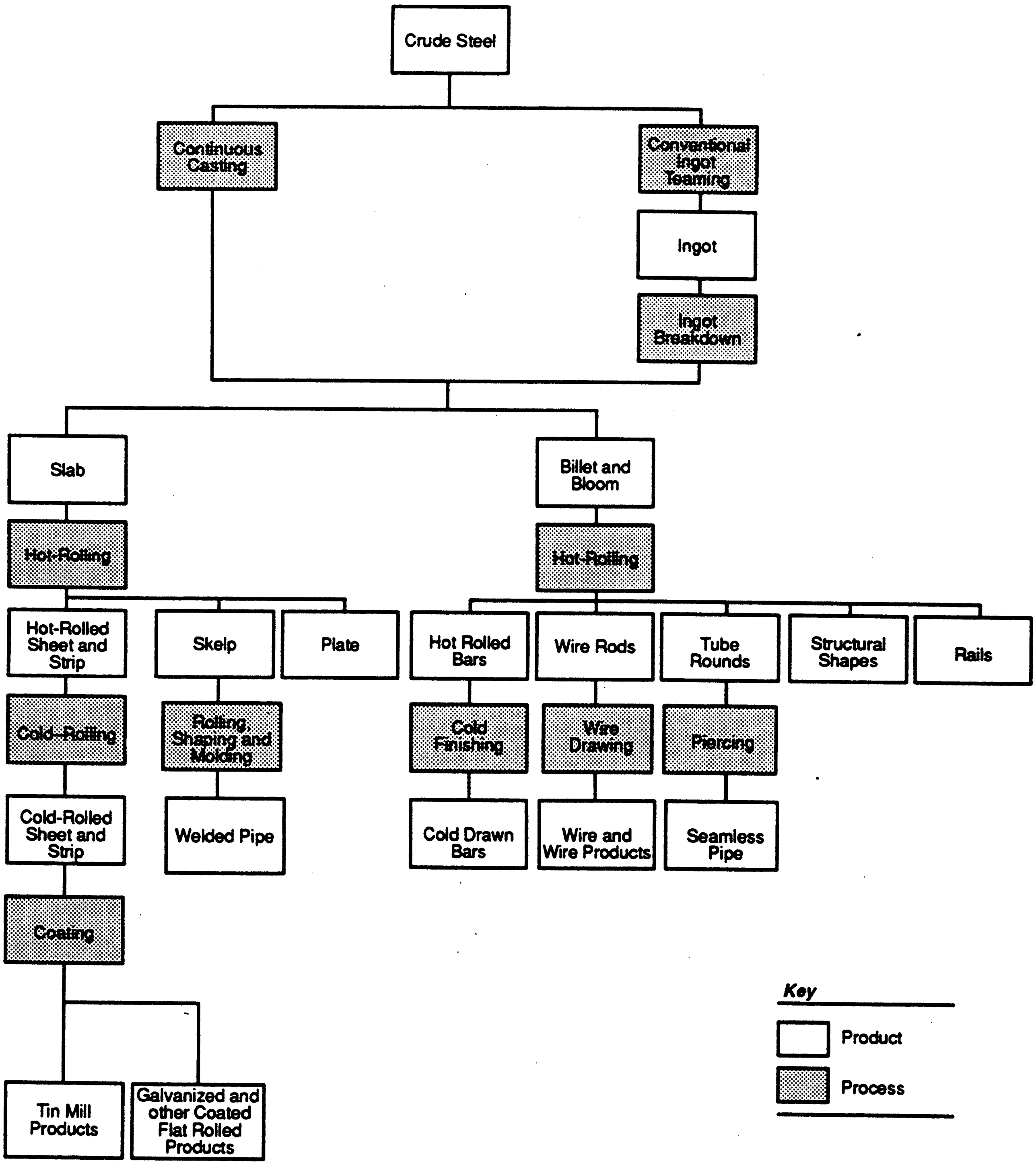


Figure 2-3
Steel products and processes



Continuous casting, the newer process, bypasses several steps of the conventional ingot casting process by casting steel directly into semifinished shapes. Molten steel is poured into a reservoir (called a tundish) from which it is released into the molds of the casting machine. As the column of steel descends through the molds, water sprays cool the cast steel, resulting in solidification. The many benefits derived from this quicker casting method include increased yield, improved product quality, decreased energy consumption, and less pollution.[2]

[2] United States Steel, *The Making, Shaping and Treating of Steel*, 10th ed. (1985), p. 745.

The final result of both conventional ingot teeming and continuous casting is steel in one of three semifinished shapes: slabs, blooms, or billets. Slabs are wide semifinished products from which flat rolled sheets, strips and plates are made. After passing through a hot strip mill, a slab takes the form of either plate or a coil of thin sheet. Coils may be shipped to customers directly or may undergo further processing, including cold rolling, to form cold rolled sheet; slitting, to form steel strip; and welding, to form welded pipe. Sheets and strips are used in construction, appliances, auto bodies, electrical machinery, and a variety of other products. For applications where corrosion resistance is important, sheet is generally coated. Zinc coatings (galvanized) are used in many automotive and appliance industry applications, and tin coatings are commonly used in canning and container applications. Blooms and billets, long shapes with square or rectangular cross sections, are frequently used to manufacture structural shapes, rails, bars, and rods; these products are principally used in the construction industry.

Principal Steel Consumers

Steel is consumed in many sectors of the economy. Major consuming industries include the construction, automotive, machinery and equipment, shipbuilding, container, appliance, and oil and gas industries. The amount of steel consumed by any nation generally reflects the relative importance of its agricultural, service, or manufacturing sectors, the latter using steel most intensively.

The International Steel Industry

Firms in the international steel industry are a heterogeneous group with increasingly diverse characteristics. Different corporate structures that exist within each nation appear to reflect a mix of business cultures and corporate strategies developed to address a changing competitive environment.

Market entry by minimills and firms from developing nations, for instance, has introduced additional competitive pressures in national and international markets. In response, many firms in the developed world have altered their product mix and the degree to which they are involved in other lines of business.

In the United States, privately owned steel firms compete in a market that is one of the most competitive in the world. Recent experience has caused most of the major integrated U.S. steelmakers to focus solely on steelmaking operations within a narrowing, although high value-added, range of product markets. The narrowed focus may make it easier to meet the increasingly sophisticated requirements of principal domestic consumers; it may also facilitate the channeling of investment capital toward a narrower range of production facilities.

Location of Major Firms

The developed countries of the Western World have long dominated the steel industry in terms of production and trade, due in large part to their relatively early development of steel-consuming industries (e.g. automotive, machinery) and steel-intensive infrastructure (e.g. roads, buildings). As late as 1970, the world's 20 largest steelmakers were located in only four developed regions or countries (table 2-1): Western Europe (8 companies), the United States (7 companies), Japan (4 companies), and Australia (1 company).

Since 1970, however, a number of steelmakers located in developing countries have come to rival firms in developed countries in terms of size. In 1990, three companies from the developing world were among the world's largest 20: POSCO (Korea), SAIL (India), and China Steel (Taiwan).[3] These companies were the beneficiaries of industrialization programs designed to promote the formation of heavy industries and the substitution of domestically produced steel for imports (as discussed in chapter 3).

Other significant market entrants during 1970-90 were minimills. As shown in table 2-2, a few are presently among the world's largest 50 steelmakers: Tokyo Steel (Japan), Nucor (United States), North Star (United States), Gerdau (Brazil), and Toa Steel (Japan). Although there are clear differences in the origin, ownership, and management of these firms, minimill producers share the benefits of technological developments that reduced barriers to entry in the steel industry. Continuing implementation of newly-developed technology, moreover, is creating new opportunities for minimills in higher value-added markets, which over time will likely reshape national and international markets. The development and incorporation of beam blank casting technology (see Glossary of Technical Terms, appendix D), for instance, which casts shapes suitable for rolling into structural shapes, is rapidly changing the structure of the U.S. structural steel market and is being observed with great interest by certain European mills.[4] Further examination of these technologies and their impact on specific markets is found in chapter 3 in the section on technology.

Market Power

Some of the world's steelmaking companies are in a position to exercise significant power in home markets as a result of their size. The world's ten largest steelmaking firms account for greatly different

[3] In 1989, 5 of the largest 20 companies were located in the developing world. During 1990, the Brazilian Government separated Siderbras (formerly the steel industry's third-largest company) into a number of smaller units, some of which still appear among the largest 50 steelmakers (Usiminas, Cosipa, and CSN).

[4] Representatives of EC steel companies, interviewed by Commission staff, April 1991.

Table 2-1
Western world's largest 20 steelmakers, 1970[1]

Ranking	Company	Country	Raw steel production: Quantity	Raw steel production: Share of world
			Million metric tons	*Percent*
1	Nippon Steel[1]	Japan	33.6	5.1
2	USS	United States	28.8	4.4
3	British Steel	United Kingdom	25.2	3.9
4	Bethlehem	United States	18.7	2.9
5	NKK[1]	Japan	12.9	2.0
6	ATH[2] (Thyssen)	West Germany	12.6	1.9
7	Sumitomo Metal[1]	Japan	11.2	1.7
8	Kawasaki	Japan	11.0	1.7
9	Finsider	Italy	9.7	1.5
10	Republic	United States	8.8	1.3
11	Wendel-Sidelor	France	8.2	1.3
12	Usinor	France	8.0	1.2
13	National	United States	7.6	1.2
14	Armco	United States	7.2	1.1
15	BHP[3]	Australia	6.8	1.0
16	Hoesch[2]	West Germany	6.8	1.0
17	Inland	United States	6.4	1.0
18	Arbed	Luxembourg	6.4	1.0
19	Jones & Laughlin	United States	6.3	1.0
20	Cockerill	Belgium	([4])	([4])

[1] Calendar years or fiscal year ending Mar. 31, 1971.
[2] Fiscal year ending Sept. 30, 1970.
[3] Fiscal year ending May 31, 1971.
[4] Not available.

Source: *Metal Bulletin Handbook*, 1972, published by Metal Bulletin Ltd., London.

shares of their nation's steel production (table 2-3). Ratios are particularly high in the case of France, the United Kingdom, and Korea. Major firms account for relatively small shares of domestic markets in the United States, Japan, and West Germany.

One analyst has noted that a company's dominance in its home market appears to be highly correlated with its provision of broad product ranges.[5] This correlation seems to hold for companies such as Usinor Sacilor, British Steel, BHP (Australia), and Sidor (Venezuela). The advantages and disadvantages of maintaining broad product ranges are discussed later in this chapter.

Ownership

Eighteen of the largest steelmakers in the Western world are partially or wholly owned by governments (table 2-2); moreover, virtually all production in Central and Eastern Europe and the USSR is state-owned. Government-owned companies in the developed world are principally located in Europe; as discussed in chapter 3, governments acquired ownership in response to the crises experienced by the industry during the 1970s and 1980s. Government-owned companies in the developing world, on the other hand, were typically state-held from their inception. The effect of state ownership on competitive conditions in the industry is discussed at greater length in chapter 3.

Diversification

As a result of the historical development of Japanese keiretsu and German holding companies, Japanese and German companies are among the most diversified steelmakers in the world. Thyssen Handelsunion, for instance, conducts business not only in the steel industry, but in the coal and coke, recycling, oil and petrochemical, distribution, engineering, construction, and shipbuilding industries. Thyssen also conducts business in industries that compete with steel, such as the plastic, aluminum, and ceramics industries. In Japan, Sumitomo Metal Industries belongs to Japan's Sumitomo conglomerate, which engages in metal and coal mining, machinery and shipbuilding, and engineering in addition to steel production and distribution. Kawasaki Steel belongs to the Daiichi Kangyo Bank Group, which includes Furukawa Mining, Furukawa Electric, Furukawa Aluminum, Niigata Engineering, Fuji Electric, Fujitsu, Kawasaki Heavy Industries, and C. Itoh and Co. (a prominent trading company).

At the other end of the spectrum are U.S., British, and French firms, many of which withdrew from nonsteelmaking operations during the 1970s and 1980s to concentrate scarce financial resources on their primary business. The most notable exception in the United States is USX Corporation, which derives about two-thirds of yearly sales from its energy business.

[5] The WEFA Group, *Conquering World Steel Markets: Forecast and Analysis through 2000, Report Overview* (1990), pp. 1-2.

Table 2-2
Western world's largest 50 steelmakers, 1990

			Raw steel production		*Ownership*	*Type*
Ranking	*Company*	*Country*	*Quantity*	*Share of world*	*P=Private G=Government*	*I=Integrated M=Minimill*
			Million Metric tons	*Percent*[1]		
1	Nippon Steel	Japan	28.8	3.7	P	I
2	Usinor Sacilor	France	23.3	3.0	G	I
3	POSCO	Korea	16.2	2.1	P/G	I
4	British Steel	United Kingdom	13.8	1.8	P	I
5	USS	United States	12.4	1.6	P	I
6	NKK	Japan	12.1	1.6	P	I
7	ILVA	Italy	11.5	1.5	G	I
8	Sumitomo Metal	Japan	11.1	1.5	P	I
9	Thyssen	Germany	11.1	1.5	P	I
10	Kawasaki	Japan	11.1	1.5	P	I
11	Bethlehem	United States	9.9	1.3	P	I
12	SAIL	India	8.7	1.0	G	I
13	Arbed	Luxembourg	7.7	1.0	P/G	I
14	LTV	United States	7.4	1.0	P	I
15	Kobe Steel	Japan	6.6	0.8	P	I
16	ISCOR	South Africa	6.3	0.8	P	I
17	BHP	Australia	6.3	0.8	P	I
18	China Steel	Taiwan	5.4	0.8	P/G	I
19	Dofasco	Canada	5.2	0.7	P	I
20	National	United States	5.2	0.7	P	I
21	Hoogovens	Netherlands	5.2	0.7	P/G	I
22	Inland	United States	4.8	0.6	P	I
23	Armco	United States	4.8	0.6	P	I
24	Cockerill Sambre	Belgium	4.4	0.6	P/G	I
25	Krupp Stahl	Germany	4.3	0.6	P	I
26	Sidermex	Mexico	4.2	0.6	G	I
27	Peine-Salzgitter	Germany	4.2	0.6	P	I
28	Voest Alpine	Austria	4.1	0.5	G	I
29	Hoesch	Germany	4.1	0.5	P	I
30	Ensidesa	Spain	4.0	0.5	G	I
31	Nisshin Steel	Japan	3.6	0.5	P	I
32	Tokyo Steel	Japan	3.5	0.5	P	M
33	Usiminas	Brazil	3.5	0.5	G	I
34	Klockner	Germany	3.4	0.4	P	I
35	Nucor	United States	3.1	0.4	P	M
36	Mannesmann	Germany	3.0	0.4	P	I
37	COSIPA	Brazil	2.9	0.4	G	I
38	CSN	Brazil	2.9	0.4	G	I
39	SSAB	Sweden	2.8	0.4	P/G	I
40	Sidor	Venezuela	2.7	0.4	G	I
41	North Star	United States	2.5	0.3	P	M
42	Stelco	Canada	2.5	0.3	P	I
43	Rouge Steel	United States	2.5	0.3	P	I
44	TDCI	Turkey	2.4	0.3	G	I
45	Weirton	United States	2.4	0.3	P	I
46	Rautaruukki	Finland	2.4	0.3	G	I
47	Gerdau	Brazil	2.4	0.3	P	M
48	Toa Steel	Japan	2.4	0.3	P	M
49	Tata Iron & Steel	India	2.3	0.3	P	I
50	Wheeling-Pittsburgh	United States	2.3	0.3	P	I

[1] Calculated from unrounded data.

Source: *Metal Bulletin*, Feb. 25, 1991, p. 19, Thomas R. Howell et al., *Steel and the State: Government Intervention and Steel's Structural Crisis* (Boulder and London: Westview Press, 1988), p. 539, and International Iron and Steel Institute.

Table 2-3
Concentration ratios of top 10 steelmakers, 1990

Company	*Country*	*Company production (1)*	*Domestic production[1] (2)*	*Share of domestic production (1)/(2)*
		Million metric tons		*Percent*
Nippon Steel	Japan	28.8	110.3	26
Usinor-Sacilor[2]	France	23.3	19.0	123
POSCO	Korea	16.2	23.1	70
British Steel	U.K	13.8	17.9	77
USS	U.S	12.4	88.9	14
NKK	Japan	12.1	110.3	11
Ilva	Italy	11.5	25.4	45
Sumitomo	Japan	11.1	110.3	10
Thyssen	Germany	11.1	38.4	29
Kawasaki	Japan	11.1	110.3	10

[1] Preliminary.

[2] Includes production of subsidiaries and divisions located in Germany and Italy.

Source: Compiled on the basis of data contained in *Metal Bulletin*, February 25, 1991 and statistics of the International Iron and Steel Institute.

Other companies, such as British Steel, Usinor Sacilor, and Inland have broadened their steel involvement by expanding steel distribution activities. In the case of the European firms, the companies' efforts appear related to intentions to globalize in preparation for fuller European integration in 1992.

Firms that have diversified vertically or horizontally (or in both ways, in the case of German and Japanese companies) have both advantages and disadvantages relative to nondiversified firms. Vertically-integrated firms, for example, may be able to obtain raw material inputs on more favorable terms than nonvertically-integrated firms when market conditions are tight; on the other hand, they may be obligated to obtain inputs on relatively unfavorable terms when consumption in factor markets is low. The same may hold true with respect to relationships with steel-consuming industries. As a result, such firms are somewhat less subject to the vicissitudes of the factor and product markets. Horizontally-integrated firms have the benefit of balancing their cyclical steel business with noncyclical or counter-cyclical businesses. Perhaps more important, however, is that vertically or horizontally integrated firms appear better positioned to forge close supplier relationships with steel consumers that belong to the same business group or holding company.

Product Range

Competitive pressures have resulted in the divestiture of certain steelmaking facilities by some companies in order to concentrate financial resources and managerial and labor skills on facilities most important to their largest or most important customers. U.S. integrated mills, for instance, have been narrowing their product range for a number of years in response to competition from minimills in the market for bars and rods and, more recently, in the market for medium and heavy structurals. With the exception of U.S. Steel and Bethlehem Steel, which maintain bar and structural operations, and Inland Steel, which still operates barmaking facilities, the major integrated steelmakers in the United States have chosen to specialize by improving their competitive position in the higher value-added markets for hot-rolled, cold-rolled, and coated sheet and strip. A similar trend is evident among Japanese integrated producers, although it appears that a high level of Japanese construction activity has temporarily reduced the pressure to reduce barmaking and structural activities.

Integrated mills in the European Community, on the other hand, have in most cases maintained relatively broad product ranges, including long products (i.e., bars, light structurals, and wire rod). As in the United States, the EC's largest producers, Usinor Sacilor and British Steel, are active participants in the long product markets; Usinor Sacilor derives approximately one-third of its total steel sales from its long products business, while British Steel is one of the world's more important producers of structural shapes. Unlike the United States, a large number of the smaller integrated plants in Europe appear to have maintained bar or structural facilities as well.

The most obvious advantage of maintaining a broad product range is the ability to compensate for weak consumption in some product markets with strong performance in others. However, a number of disadvantages appear to accompany the maintenance of broad product ranges. Among these is the need to invest in a broader range of facilities to meet the increasing demand for highly specialized steel.

Insights From Historical Experience

Changes in the pattern of global steel supply, demand, and trade since 1970 have fundamentally altered the structure of the global steel industry. For U.S., European, and Japanese steelmakers these changes resulted in sharp reductions in production and employment as well as financial losses in the mid-1970s and early 1980s. During the same period, steelmakers in a small number of developing countries rapidly emerged as global competitors.

Recession, Expansion, and Financial Losses

The global recession following the petroleum price increases in the early 1970s marked a turning point for the steel industry. After decades of almost uninterrupted growth in steel demand, steel consumption among industrialized countries began to fall. Among developing and centrally-planned economy (CPE) nations, however, consumption continued to increase. This increased consumption was in part met by expanded exports from steel producers in industrialized countries, particularly those in Japan. However, in many countries where consumption was growing, such as Brazil, Korea, China and India, large domestic steel industries emerged, often with direct assistance from the national governments. The resulting increase in national self-sufficiency in steel not only diminished export opportunities for steelmakers in industrialized countries, but it posed a more direct threat in their home markets, as these new steelmakers began to export to the United States, Europe, and, to a lesser extent, Japan.

The expansion of steelmaking capacity in developing and CPE countries, coupled with continued (though slower) capacity growth in industrialized countries, meant that global capacity increased much faster than steel consumption. This resulted in substantial levels of unused capacity, which peaked in 1982 when a global economic recession resulted in a sharp decline in steel consumption, and hence, steel prices.

By the mid-1970s, steelmakers in industrialized nations began to sustain large financial losses and by the early- to mid-1980s, they were forced to take a series of actions designed to make them more competitive. They cut capacity, reduced production and employment, narrowed their product range, consolidated operations, invested in remaining facilities, implemented new technologies, and restructured management. In addition, many benefitted from a variety of government policies and industry regulations designed to stabilize markets and limit import surges.

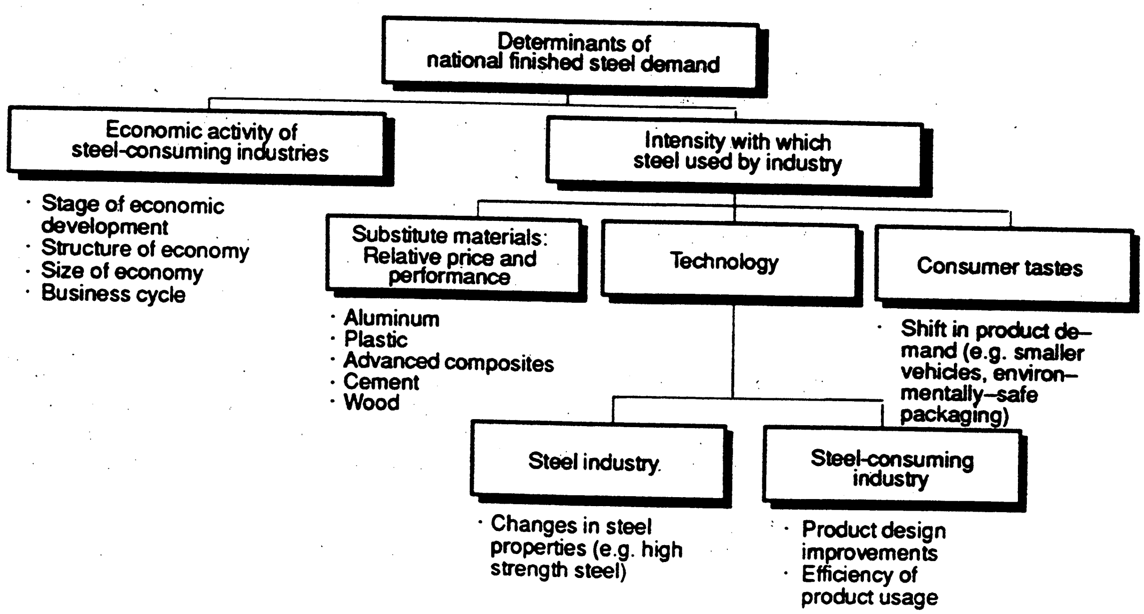
As a result of these restructuring efforts, surplus capacity has been trimmed and surviving steelmakers in industrialized nations have improved their ability to compete globally. The sections that follow highlight the major developments in world steel supply and demand patterns, and assess the implications of these developments in terms of trade, employment, and financial conditions.

Developments In Steel Consumption

After stone and cement, steel is the most widely used material in the world[6] and certainly one of the most versatile. Demand for steel is a function of two factors: the level of economic activity in steel-consuming industries (particularly construction, machinery and equipment, and automotive) and the extent to which such industries use steel (figure 2-4).

[6] U.S. Bureau of Mines, *Minerals Yearbook 1988*, vol. III, pp. 7-9.

Figure 2-4
Determinants of national finished steel demand



An examination of these factors shows why, in the past 20 years, global steel consumption did not increase as steadily as it had before 1970 (figure 2-5). With respect to economic activity, slow economic growth after 1974 and, in particular, the economic downturns in 1975 and 1982, slowed construction as well as machinery and auto production, and therefore diminished steel demand. With respect to the intensity of steel use, new materials, especially aluminum and plastics, began to replace steel in many applications. New technologies, implemented by steel producers and consumers, reduced the volume of steel required. And shifts in consumer tastes, such as increased demand for more fuel-efficient automobiles, prompted by higher fuel prices, reduced steel demand.

The global trend in steel consumption is perhaps best understood by contrasting the experience of industrialized countries with that of developing and CPE countries. The industrialized countries consumed only 46 percent of the world's steel during 1985-89, compared to over 60 percent during 1970-74 (table 2-4).[7]

[7] The relative decline in steel demand in the industrialized world is more pronounced if Japan is excluded. Rapid industrial growth and continued infrastructure building put Japan in a unique position among advanced industrialized countries, as Japanese steel consumption grew considerably between 1974 and 1989.

As discussed below, the geographic shift in steel consumption during the study period can be explained in terms of regional variations in the economic activity of steel-consuming industries (discussed below) and the varying intensities with which steel was used by these industries (discussed later in the chapter).

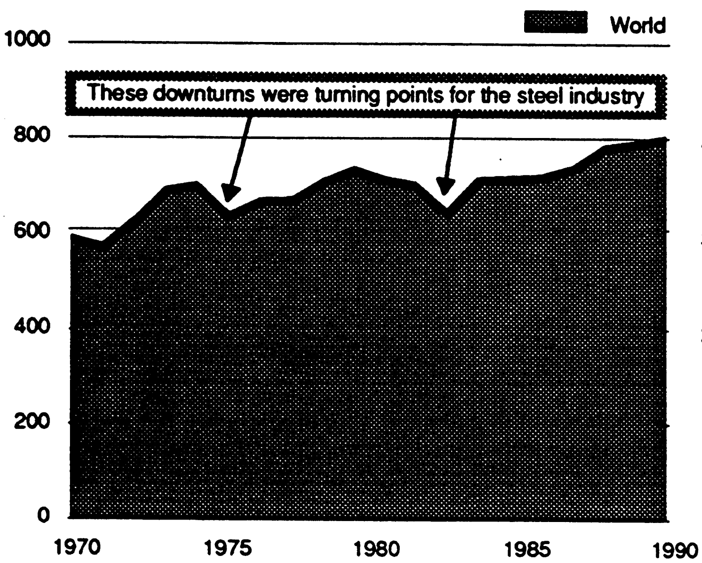
Steel Consumption and Economic Activity

Studies on the correlation between economic activity and steel consumption suggest that although steel consumption tends to rise with economic output, this relationship is not linear; rather, as economies approach an advanced industrialized stage, steel consumption stagnates or declines, reflecting two underlying changes in economic structure. First, the relative role of the manufacturing sector in these economies has tended to decline as manufacturing operations moved offshore and were replaced by service industries, which generally use steel less intensively.[8] Second, within the manufacturing sector, growth has been greatest in segments that use steel least intensively (e.g., electrical machinery and appliances, radio and communications equipment,

[8] The exception is Japan, where the growth of the manufacturing sector has exceeded that of the service sector.

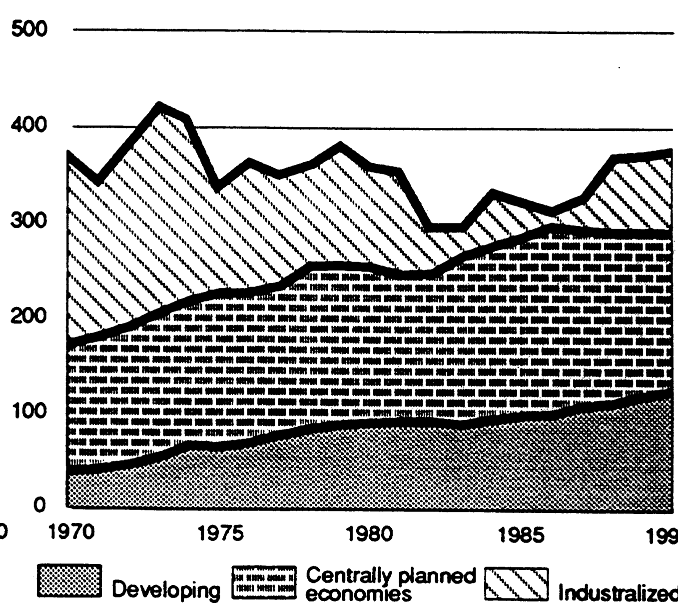
Figure 2-5
Apparent steel consumption, world and by region, 1970-90
Steady growth in developing and CPE countries vs. decline in industralized countries

Global apparent steel consumption
Million metric tons



Note.—Figures are in crude steel equivalents.
1990 figures are estimates.
Source: International Iron & Steel Institute.

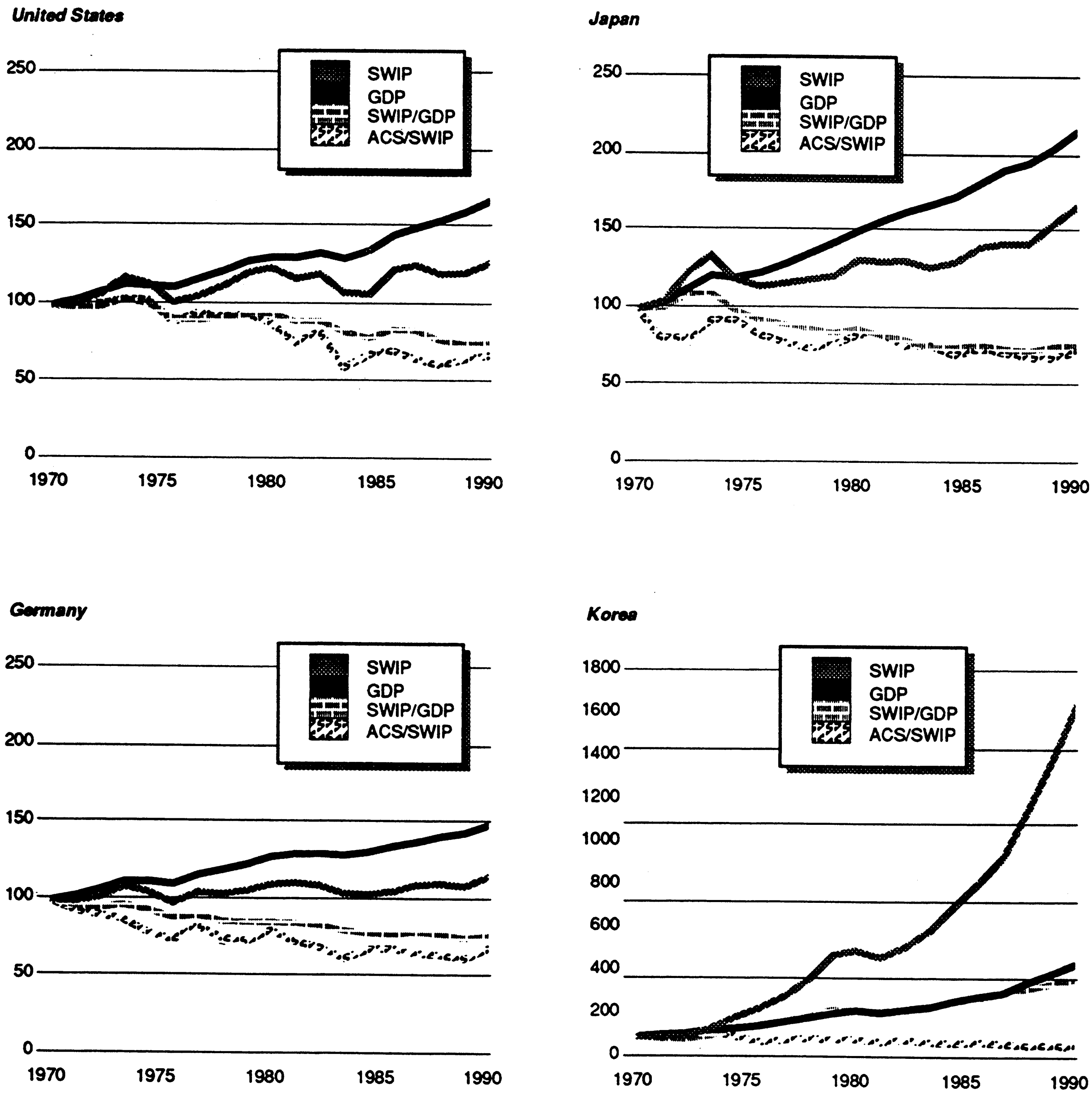
Apparent steel consumption, by region
Million metric tons



Note.—Figures are in crude steel equivalents.
1990 figures are estimates.
Source: International Iron & Steel Institute.

Figure 2-6
Steel consumption, economic activity, and steel intensity, by selected country, 1970-90
Activity of steel-consuming industries relative to gross domestic product drops in industrialized countries, rises in Korea; intensity of steel use declines in each country

1970=100



Note.—SWIP stands for steel-weighted industrial production. SWIP/GDP stands for the ratio of SWIP to GDP and measures activity of steel-consuming industries relative to overall economic activity. ACS/SWIP stands for the ratio of apparent consumption of steel to SWIP, and measures the intensity with which steel is employed.

Source: International Iron and Steel Institute, *Changing Patterns of Industrial Development and the Steel Industry*, Volume I - General Analysis, (1990).

Table 2-4
Crude steel: Apparent consumption, by region, as a percent of world total
(In percent)

	Industrialized	*Developing*	*Centrally planned economies*
1970-74	61.4	8.4	30.3
1974-79	52.7	11.8	35.5
1980-84	48.0	14.0	38.0
1985-89	45.8	14.9	39.3

Source: Calculated from statistics of the International Iron and Steel Institute.

office and computing equipment, and scientific and measuring devices).[9]

The importance of these trends is illustrated by examining a steel-weighted industrial production index (SWIP), which assigns weights to industries according to their consumption of steel to measure the overall activity of steel-consuming industries. Compared to the gross domestic product (GDP), the SWIP has fallen in industrialized economies, indicating that output by those sectors of the economy that use steel most intensively dropped compared to economic activity as a whole (figure 2-6).

Largely as a result of the declining output of steel-consuming industries, steel's role in the economy has fallen considerably in major industrialized countries. As illustrated in figure 2-7, the ratio of steel consumption to GDP has declined steadily in major industrialized countries since 1970. In the last half of the 1980s, however, the SWIP of industrialized economies has improved, leading some industry analysts to speculate that the drop in economy-wide steel intensity may be reaching a low point.[10] In major developing countries, on the other hand, the output of steel-consuming industries rose during the study period, and consequently, steel's role in their economies either grew (Korea, Taiwan) or remained stable (Brazil, India).

By plotting the experience of several countries together on a single graph (figure 2-8), one can more clearly see a relation between the level of economic development as measured by GDP per capita and steel intensity as measured by steel consumption as a percent of GDP. The figure suggests that once a developing country's wealth reaches approximately $2,000 per capita, steel intensity grows, at first rapidly and then more moderately. After peaking at a point of moderate development, approximately $6,000 per capita, steel intensity begins to fall slowly. This is followed by more rapid decline and finally stabilization. The magnitude of these changes may vary from one country to another, as does the period of time it takes for a given country to pass through this cycle. Nevertheless, this pattern can be traced for most countries throughout their development cycle.

Although industrial structure and level of economic development are important in explaining the long-term shift of steel consumption from industrialized to developing and CPE nations, other macroeconomic factors are more applicable to short-term shifts among Western (non-CPE) countries. In market economies, steel consumption closely parallels the upturns and downswings in the business cycle. A drop in U.S. apparent steel consumption by 18 percent in the first quarter of 1991 (relative to first quarter 1990), for example, reflects the impact of the recession in the United States. The two largest steel-consuming industries, construction and automotive, were forced to cut back on construction and production schedules, and as a result, the level of steel they consume diminished.

Another factor that directly influences steel consumption patterns in the short and medium term is indirect trade in steel, or trade in manufactured goods that contain steel, such as automobiles or industrial equipment. Indirect imports displace steel contained in goods produced by domestic manufacturers, thereby reducing steel consumption in the home market. Indirect exports, on the other hand, increase domestic steel consumption. There are many factors that influence indirect trade in steel, though perhaps the strongest is exchange rates. In the early 1980s, the high value of the dollar encouraged a significant number of U.S. steel-consuming manufacturers to move operations offshore, shifting the bulk of their steel purchases to non-U.S. producers. Additionally, the high dollar made steel-containing goods produced by foreign manufacturers more attractive relative to U.S. goods. These trends contributed to the downturn in U.S. steel consumption in the early 1980s.

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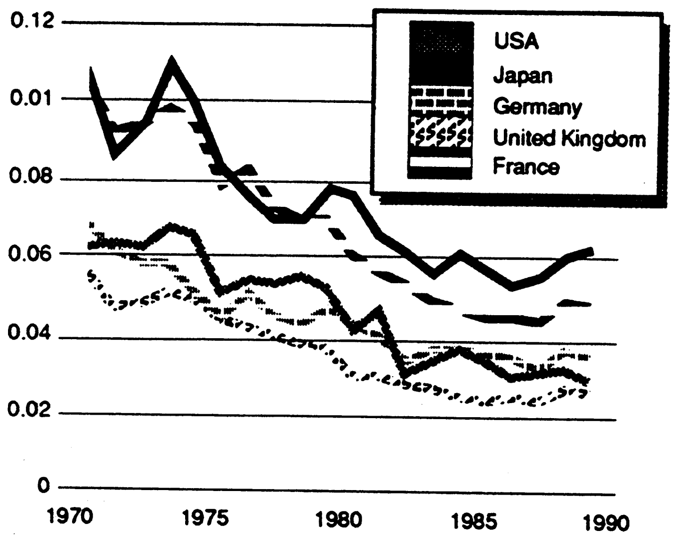
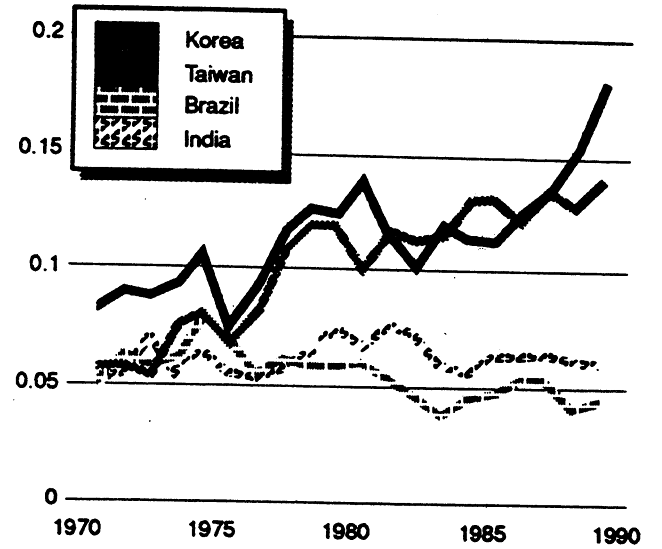
[9] International Iron and Steel Institute (IISI), *Changing Patterns of Industrial Development and the Steel Industry: vol. I - General Analysis* (Brussels, 1990), p. 3-1.

[10] IISI, *Changing Patterns*, p. 3-25.

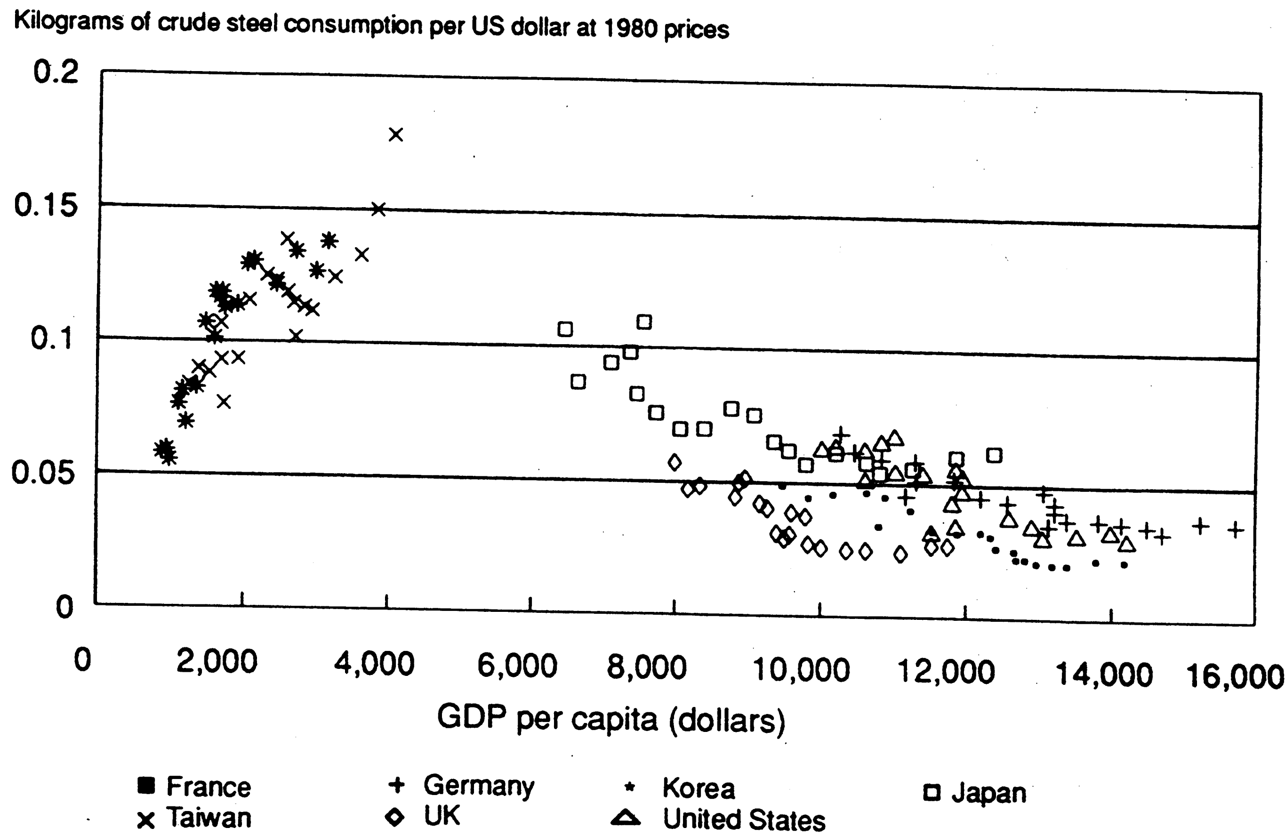
Figure 2-7
Steel intensity of GDP, 1970-90: Declining in industralized countries, steady or rising in developing countries





Source: International Iron and Steel Institute, *Changing Patterns of Industrial Development and the Steel Industry*, Volume I - General Analysis, (1990).

Figure 2-8
Steel intensity of GDP, 1970-89: Reduced intensity generally follows initial rise



Source: Compiled from statistics of International Iron and Steel Institute, *Changing Patterns of Industrial Development*, International Monetary Fund, *International Financial Statistics Yearbook*, Council for Economic Planning, *Taiwan Statistical Data Book*.

Factors Affecting Intensity of Steel Use

The intensity with which steel is employed by consuming industries also affects consumption patterns. In many applications, the amount of steel required to produce a unit of output has fallen over the past 20 years. As a result, consumption of steel has fallen relative to the output of steel-consuming industries, as indicated in figure 2-6. Competition from substitute materials, improved technology, and shifting consumer tastes all contributed to this decline, though to varying degrees depending on the region.

Substitute Materials

Competition from substitute materials, such as wood, cement, and glass, is longstanding. More recently, however, developments in aluminum, plastics, and advanced composite technology have allowed these materials to make inroads with traditional steel consumers. The contrast in consumption trends between steel and its substitutes is sharp (table 2-5). For the major industrialized nations listed below, consumption of aluminum and plastics rose sharply during 1968-73, while finished steel consumption grew only moderately, at a pace roughly comparable to that of cement. And while steel consumption declined during 1973-84, aluminum and plastics consumption generally continued to grow.

Of course, not all of the increase in aluminum and plastics consumption has come at the expense of steel. In many applications, aluminum and plastics do not compete with steel. Nevertheless, the consumption trends shown below serve as an indicator of the relative success of steel's main material substitutes.

Efforts made by steelmakers have enabled them to curtail further erosion of market share in some cases and recapture lost markets in others. For example, since 1974, steel prices have increased more slowly than prices of substitute materials in major industrialized nations, largely due to cost containment efforts by steelmakers. Had the relative price of steel increased, the substitution of steel by aluminum and plastics likely would have been greater (figure 2-9).

Other attempts to reduce or reverse replacement by substitute materials are more sector specific, and the experience varies by region. In the auto industry, for example, although plastics have replaced steel in many applications (e.g. dashboards, fenders, and inner panels), substitution has not been nearly as widespread as many industry experts expected at the beginning of the 1980s. In a 1982 survey conducted by the University of Michigan's Transportation Research Institute, for example, half of the respondents predicted that the average 1990 U.S.-produced passenger car would contain between 800 pounds and 1,100 pounds of low carbon steel; today, estimates suggest that it is closer to 1,400 pounds. In the same survey, most respondents predicted that plastics would make up about 300 pounds of the average 1990 car; recent estimates suggest it contained 229 pounds.[11] The underestimate of steel use stemmed in large part from expectations that the average 1990 automobile would weigh less than it actually did. But this also suggests that many experts in the auto and auto-supplying industries did not foresee the improvements made by the steel industry. While plastics manufacturers worked to overcome obstacles to increased use, such as recyclability and heat-resistance, steelmakers improved the competitiveness of their product through improved technology.

Among the top three auto-producing nations, plastic for automotive use appears to have met the most success in Germany. In 1988, plastic made up 13 percent of German passenger cars by weight, rising from 7 percent a decade earlier. In the United States

[11] The survey, conducted every two years, gathers opinions of business executives, managers, and engineers who are expert in technology, materials, and marketing. Respondents include representatives of the auto industry itself as well as others working for their suppliers of components, parts and materials. *Delphi II Forecast and Analysis of the U.S. Automotive Industry Through in the 1980s: Materials* (Ann Arbor: Office for the Study of Automotive Transportation, 1982).

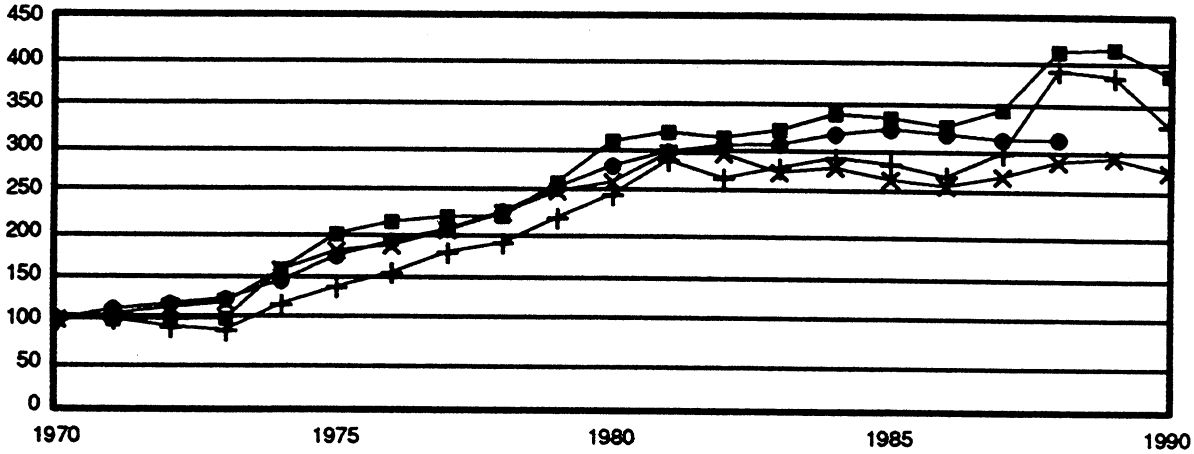
Table 2-5
Consumption of steel, aluminum, plastics, and cement, by country, 1968 to 1984
(In percent change per year)

Country	Finished Steel		Aluminum		Plastics		Cement	
	1968-73	*1973-84*	*1968-73*	*1973-84*	*1968-73*	*1973-84*	*1968-73*	*1973-84*
Industrialized countries:								
France	+4.0	-3.0	+7.8	+2.9	+14.2	+3.5	+2.8	-2.7
F. R. Germany	+2.3	-2.9	+6.8	+2.4	+12.1	+1.8	+4.2	-1.9
Japan	+9.1	0.0	+16.7	+3.3	+9.7	+3.7	+9.7	+0.4
United Kingdom	+0.6	-4.6	+3.3	-1.2	+8.9	+0.8	+1.5	-3.1
United States	+1.8	-2.2	+6.5	+0.7	+10.8	+4.2	+2.7	-0.9
Developing countries:								
South Korea	+14.4	+12.6	+2.9	+19.9	+27.2	+13.7	+10.0	+8.1
Taiwan	+12.2	+8.9	([1])	+8.1	+16.2	+15.2	+10.5	+6.1

[1] Not available.
Source: International Iron and Steel Institute, *Intermaterial Competition*, 1989, pp. 2-17.

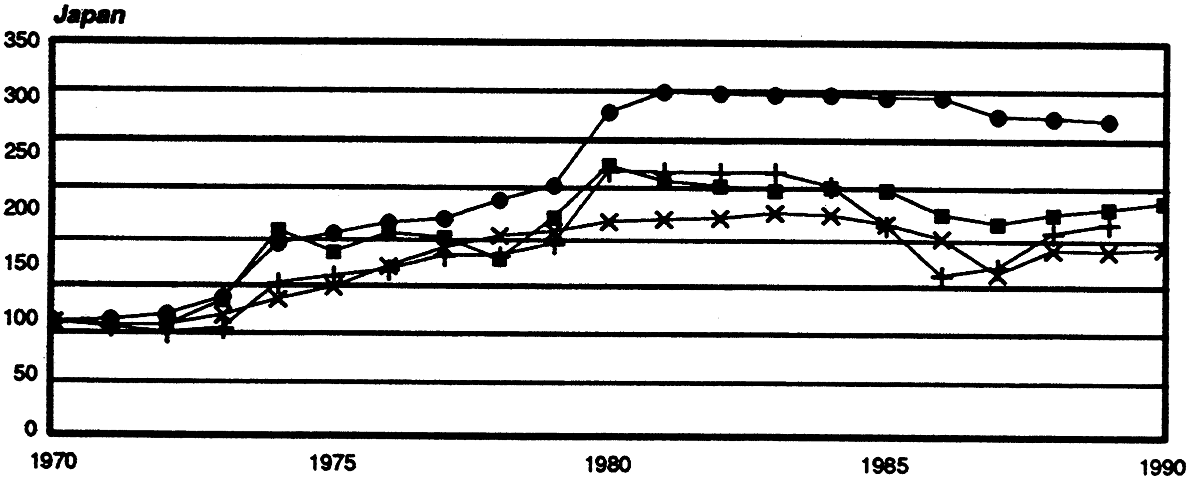
Figure 2-9
Price trends in steel and principal substitute materials in United States, Japan, and Germany, 1970-90 (1970=100)

United States



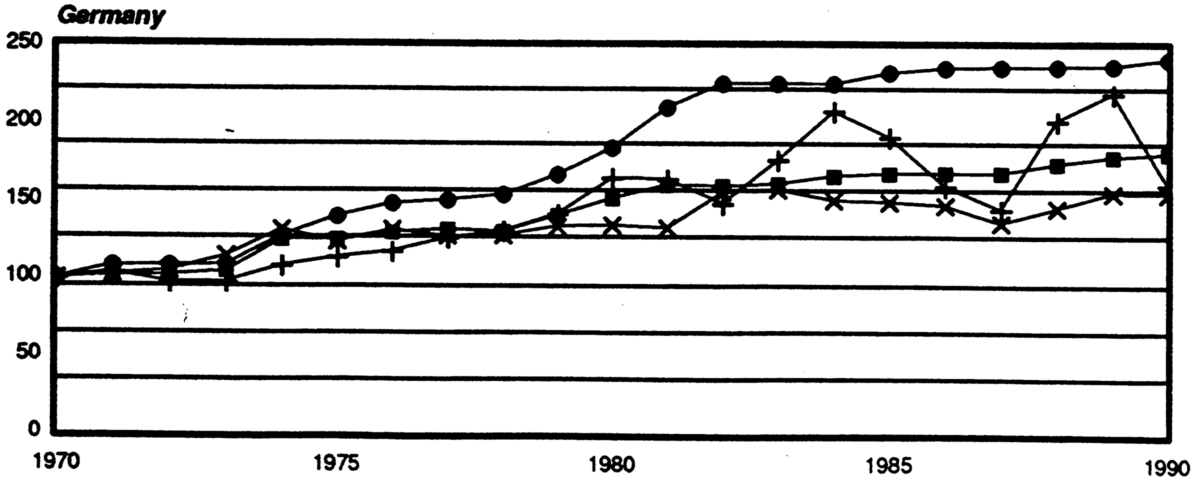
Source: PaineWebber (steel); Dow Chemicals USA, (plastic): Bureau of Labor Statistics, (cement, aluminum).

Japan



Source: PaineWebber (steel); Statistics Department, the Bank of Japan.

Germany



Source: PaineWebber (steel); Statistische Bundesamt, Wiesbaden.

Plastic — Cement — Aluminum — Steel

and Japan, plastic content reached 7 percent in the mid-1980s. With respect to steel content, German cars contain the least in percentage terms (50 percent in 1988) and Japanese cars the most (73 percent in 1986).[12] U.S. passenger cars contain approximately 55 percent steel, a decline from 59 percent in the late 1970s (table 2-6). Approximately one-quarter of the lost tonnage in plain carbon steel was compensated for by increased use of high-strength, stainless and other steels. The use of plastics has eased by 20 percent since the late 1970s.

Though few representatives from the steel and plastics industries doubt that plastics will continue to make inroads into the auto industry, they often disagree about the extent and pace of these inroads. Much may depend on the success of models with high plastic content, such as General Motor's recently-introduced Saturn model, which employs plastic in vertical panels (doors and rear quarters) and steel in horizontal panels (hoods, roofs, decks, and floor pans).[13]

Another market where steel faces intense intermaterial competition is in the container industry. Over the past twenty years, aluminum beverage cans have almost entirely replaced steel beverage cans in the United States. In Europe, however, more advanced steel technology and weaker aluminum-can recycling programs helped protect steel suppliers' share of the beverage can market. Today, steel maintains over half of the beverage can market in the Netherlands and Germany, and slightly less than half in the United Kingdom.[14] The U.S. steel industry has recently tried to strengthen its position in this market by developing lighter gauge tin-plated steel and by increasing the recycling rate of steel beverage cans. Some industry analysts expect these efforts to enable the industry to recapture an additional 3-5 percent of the beverage can market by 1995.[15] In May 1991, Canadian steelmakers were successful in convincing one of their largest beverage can consumers, Coca-Cola Beverages Ltd., to switch back to steel, after having used aluminum since 1987.[16]

In construction applications, where the main material competition comes from concrete (reinforced and pre-stressed), the market share of steel appears to be growing in some countries. In the United Kingdom, where the steel industry launched an intensive marketing and education campaign, steel for structural applications roughly doubled its market share (to 60 percent) from the early to late 1980s.[17] In Japan, the percentage of buildings that are steel framed increased from 40 percent in 1973 to 54 percent in 1986.[18]

[12] International Iron and Steel Institute, *Intermaterial Competition for the Body in White of the Passenger Car* (Brussels, 1990), p. I-6.

[13] "Saturn rolling off production lines," *American Metal Market*, Oct. 1, 1990, p. 1.

[14] "A veteran workhorse keeps pace," *Financial Times*, Nov. 1, 1990, p. 27.

[15] Representatives of the U.S. steel industry and packaging industry analysts, interviews by USITC staff, August 1990.

[16] Morgan E. Goodwin, "Canada fears big loss to municipal recycling programs," *American Metal Market*, vol. 99, May 31, 1991, pp. 1,7.

[17] U.S. International Trade Commission, *Monthly Report on the Status of the Steel Industry*, December 1989, pub. No. 2241, p. i.

[18] The Long-Term Credit Bank of Japan, *The Structural Change in the World Supply of Steel* (February, 1989), p. 28.

Table 2-6
Selected materials: Estimated weight in a typical U.S. car, 1976-90

Material	*1976-80*	*1981-85*	*1986-90*
		Pounds	
Plain carbon steel	1,913.8	1,517.9	1,438.1
High strength steel	140.6	205.5	231.1
Stainless steel	26.9	27.8	31.7
Other steels	22.2	32.3	48.5
Plastics/composites	183.6	202.7	222.8
Aluminum	108.8	134.9	149.7
All other	1,170.8	1,069.6	1,037.7
Total	3,566.7	3,190.7	3,159.6
		Percent of total	
Plain carbon steel	53.66	47.57	45.51
High strength steel	3.94	6.44	7.31
Stainless steel	0.75	0.87	1.00
Other steels	0.62	1.01	1.54
Plastics/composites	5.15	6.35	7.05
Aluminum	3.05	4.23	4.74
All other	32.83	33.52	32.84
Total	100.00	100.00	100.00

Source: Compiled from statistics in *Ward's Automotive Yearbook*, various issues.

Contributing to this increase in steel use are the declining relative price of steel and technological advancements that have improved its strength and fire resistance. In the United States, however, the steel industry appears to have been less successful in expanding its presence in the construction market; U.S. producers apparently find the market too small and cyclical to warrant the long-term commitment of resources needed for market development.[19]

Improved Technology

Aside from intermaterial substitution, another factor affecting steel demand is technology. Advances in material technology have made it possible to replace heavy steels with lighter steels in several applications. In the auto industry, for example, lighter gauge (i.e. thinner) steels were developed by steelmakers in order to maintain the competitiveness of steel as a material for auto panels and parts. Lighter steels were also developed for canning and structural applications. In the shipbuilding industry, new steel technology enabled shipbuilders to use medium plate instead of heavy plate in many applications.

In addition, as discussed in chapter 3, yield rates[20] have improved as the steelmaking process has become more efficient and, consequently, less crude steel is required to meet a given level of finished steel consumption. Developments in near net shape casting, in which steel is cast in a form that more closely resembles its final form, may similarly diminish crude steel requirements.

Increased Efficiency of Steel Consumers

Pressure to contain costs has encouraged the development of new designs and implementation of new technologies that increase product efficiency and/or reduce raw material requirements, including those for steel. In the freight industry, for example, the development of computerized controls improved the efficiency of freight car fleets, and as a result, fewer cars are needed to move a given volume of freight.[21] In manufacturing industries, increased use of computer-aided design and manufacturing has improved manufacturing techniques for many engineering applications.

Change in Consumer Tastes

Changes in consumer tastes have, in at least one instance, resulted in lower steel demand. In the auto industry, steel consumption declined when, in response to consumer demands and new government standards, auto manufacturers began to design and produce smaller, more fuel-efficient vehicles. This change affected the U.S. steel industry in particular since U.S. automakers had previously tended to produce larger vehicles than their foreign competitors. It is estimated that downsizing of cars by the U.S. auto industry accounted for a 2- to 3-percent decrease in U.S. apparent steel consumption from the mid-1970s to the early 1980s.[22]

As environmental awareness and legislation spreads worldwide, it is likely that concern regarding waste disposal will also have growing implications for the steel industry. Because steel can be completely recycled, such awareness may work to promote steel over substitute materials, such as plastics, which are not as recyclable.

Factors Affecting Supply Patterns

Production

Following a lengthy period of steady and rapid growth prior to 1974, global steel production fell in 1975 and again in 1982 as the result of global recessions. Production also became less regionally concentrated as developing and CPE nations accounted for growing shares of the global production (figures 2-10a and 2-10b). Industrialized countries, which produced nearly two-thirds of the world's steel during 1970-74, produced only half during 1985-89. During the same period, the share of world steel produced in developing countries increased from 4 percent to 12 percent, and CPE country share increased from 30 percent to 38 percent (table 2-7).

Table 2-7
Crude steel: Production in industrialized, developing, and centrally planned economy nations, as a percent of world total, 1970-89

(In percent)

Year	*Industrialized*	*Developing*	*Centrally planned economies*
1970-74	65.6	4.1	30.4
1974-79	59.3	7.0	33.6
1980-84	54.2	8.9	36.8
1985-89	50.2	11.9	37.9

Source: Calculated from statistics of the International Iron and Steel Institute.

The location of steel production is influenced by a number of factors (figure 2-11). First, regional steel consumption levels are important because economic and logistic factors often preclude extensive reliance on

[19] International Iron and Steel Institute, *Steel in Housing* (Brussels, 1988), p. 4-13.

[20] Yield rates are the ratio of crude steel output to finished steel output. The implementation of continuous casting technology has been the primary development in improving steel yield.

[21] U.S. Department of Commerce, *Steel Consumption* (October, 1987), p. 9.

[22] Estimated by staff of the U.S. International Trade Commission.

Figure 2-10a
Global steel production, 1970-90: Steady rise in developing and centrally planned economy countries, fall in industrialized countries after 1974

Million metric tons (crude steel)

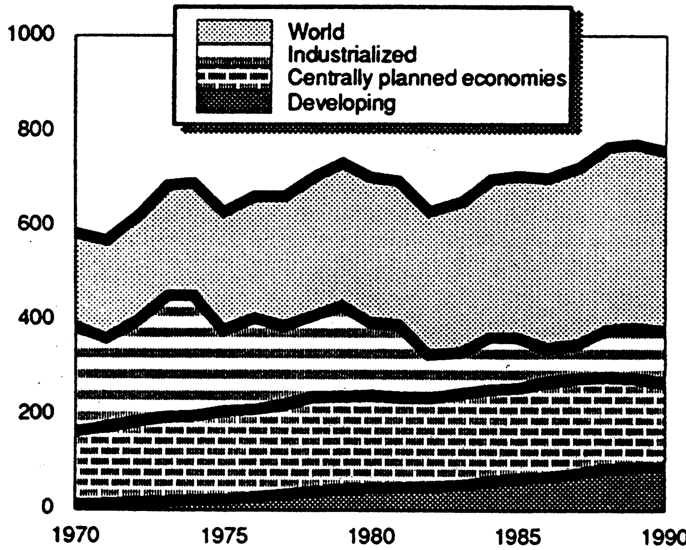
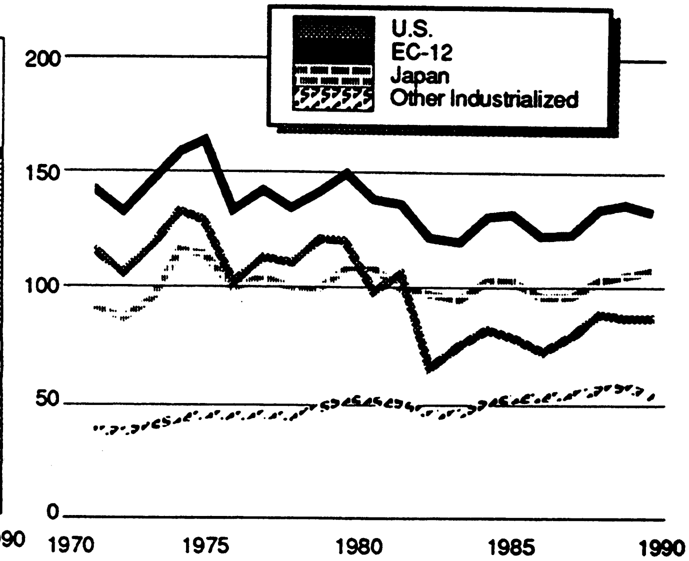


Figure 2-10b
Industrialized world steel production, 1970-90: U.S. production decline sharp, greatest during 1973-82

Million metric tons (crude steel)



Source: International Iron and Steel Institute, *Changing Patterns of Industrial Development and the Steel Industry,* Volume I - General Analysis, (1990).

Figure 2-11
Determinants of national steel supply

- Steel demand (domestic and foreign)
- Availability of capacity and technical capability
- Competitiveness of domestic industry
- Government laws and regulations
- Consumer buying practices and strategies

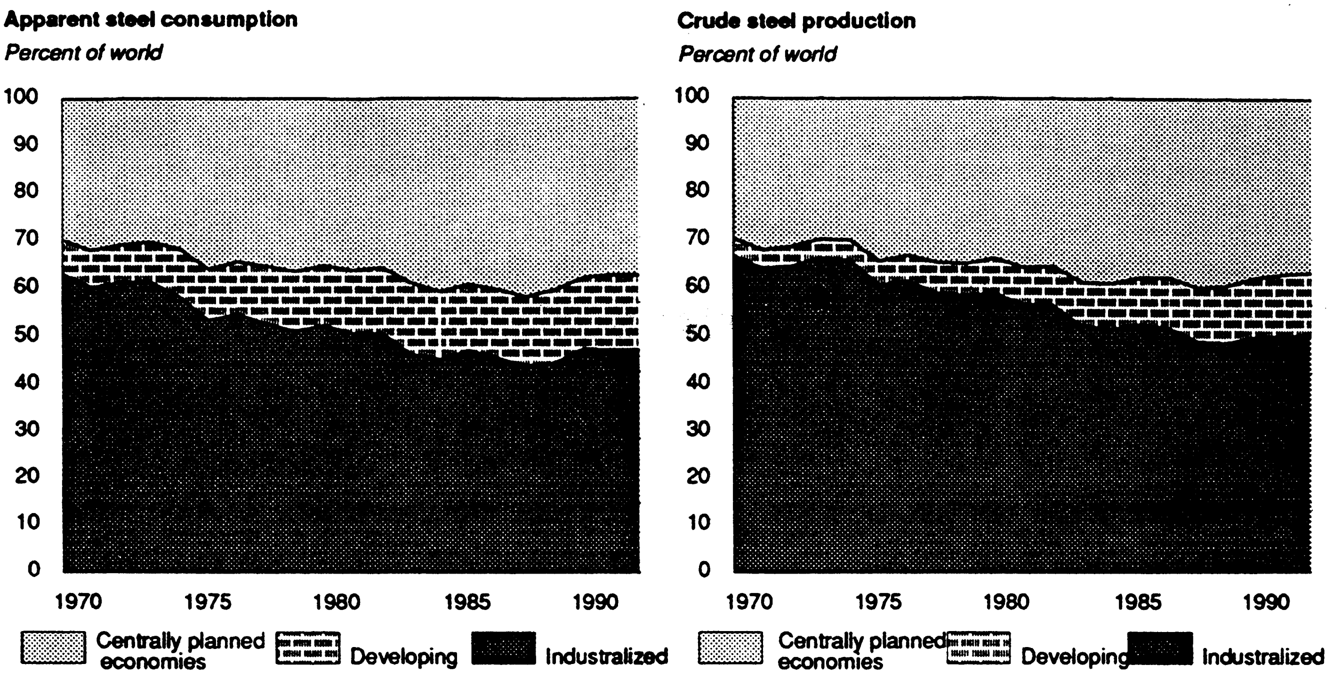
distant suppliers. The dispersion of steel consumption since 1970 therefore encouraged steel production in developing and CPE countries. The correlation between consumption and production trends is made clear by juxtaposing graphs that depict their development (figure 2-12).

Second, a country's capacity and technical capabilities dictate the quantity and types of steel it can produce. With respect to capacity, multi-billion dollar costs associated with construction of an integrated facility pose a significant entry barrier. In some developing countries, plans for building large steelmaking facilities have been and continue to be delayed due to lack of capital.[23]

Third, steel production patterns are also affected by government involvement. Governments can adopt policies that either assist the development of steelmaking capacity (e.g. subsidies, tariffs on steel imports) or hinder it (e.g. high tax rates, strict environmental laws). Part of the reason that production has shifted to developing and centrally planned economy countries is that governments have intervened to assist in the development of national steel industries (see section on government policy in chapter 3).

[23] In Indonesia, for example, plans to build an integrated steelworks beginning in the 1960s were delayed for 6 years when a new government cut off ties to the project's principal creditor, the Soviet Union. When the project was resumed in 1972, the original expansion plan was cut back considerably. Thomas R. Howell, William A. Noellert, Jesse G. Kreier, and Alan Wm. Wolff, *Steel and the State: Government Intervention and Steel's Structural Crisis.* (Boulder, CO: Westview Press, 1988), pp. 361-363.

Figure 2-12
Steel consumption vs. steel production, 1970-90
As developing and CPE nations consumed more of the world's steel supply, they also began to produce more themselves.



Note.— 1990 figures are estimates.
Source: International Iron & Steel Institute.

Source: International Iron and Steel Institute and U.K. Iron and Steel Statistic Bureau (1970-71).

A fourth factor that affects production patterns is competitiveness. If a region's steelmakers are not competitive in terms of price, quality or service, they will tend to lose business to steelmakers in another region (unless, of course, governments intervene). A region's ability to be competitive in steelmaking depends on such factors as resource availability, transportation links, and energy and labor costs. Lower wage rates in developing countries have helped many steelmakers become internationally competitive on a cost basis.

Finally, buying strategies of steel consumers affect location of steel production. For a variety of reasons, steel consumers may decide to buy from a particular steel company even if its product is not the most competitive in terms of prices, quality, and support services offered. One reason is that the steel consumer may have corporate ties with the steelmaker. As discussed earlier, many Japanese and German steel companies are part of large industrial concerns that include manufacturing operations. Even when there are no formal corporate ties, steel consumers may value long-term customer relationships or prefer to give business to selected producers. In addition, many steel users, particularly large companies that purchase high value steel, place a premium on price stability and consistent quality and service and prefer to work with a small number of steel companies for whom their business will be a priority. These consumers will often continue to source from such suppliers even when alternative sources may be cheaper or provide better service.

Each of these factors is important in explaining the pattern of steel production in industrialized, developing and centrally planned economy (CPE) countries. A review of the major trends in each of these regions follows.

Intensified Competition Among Industrialized Countries

The United States was by far the dominant steel producer after World War II, when its steel production accounted for over half of the world total. During the 1950s, the reconstruction of Europe resulted in increased steel demand, new capacity, and additional production. European steelmakers became increasingly able to meet internal steel demand and later to export.[24]

[24] Largely as a result of increased European steel production, the U.S. position as a net exporter of steel mill products ended in 1959, when over 70 percent of U.S. imports came from countries that currently comprise the European Community.

By 1960, the twelve countries that currently make up the EC produced more steel than the United States, accounting for 29 percent of world raw steel production compared with 26 percent for the United States. After increasing steadily throughout the 1960s and peaking in 1974, EC production fell by 26 percent to a low in the 1982-83 period. One reason for decreased production was greater competition in domestic and export markets, particularly from Japanese steelmakers (figure 2-10).

With active encouragement from the Ministry of International Trade and Industry, the Japanese steel industry experienced substantial growth between 1960 and 1973. Japan produced only 6 percent of the world's steel in 1960, as compared to 17 percent in 1973. Although production has generally declined in Japan since then, it has done so more slowly than in the United States and major European countries. Thus, by 1980, Japan surpassed the United States' steel production, making it the second largest steel-producing nation in the world, behind only the Soviet Union. In 1990, Japanese steel production accounted for 14 percent of world steel production.

Dramatic Growth of Developing Countries

During the late 1970s and throughout the 1980s, several developing nations emerged as major steel producers. Production in the developing world increased nearly five-fold between 1970 and 1990. By contrast, industrialized countries produced no more in 1990 than they did in 1970. As a result, the industrialized nations' share of world crude steel production fell from 67 percent to 50 percent during this period, while the share of developing nations rose from 4 to 13 percent. Brazil, Korea, and India have been the principal steel producers in the developing world since 1970; in 1990, they accounted for 57.9 percent of developing country steel production.

World Share Gains by Centrally Planned Economies

Despite the high rate of growth of the steel industries in the developing world, it was additional production among the centrally planned economy countries that accounted for a majority of the increase in global steel production between 1970 and 1990. In the Soviet Union, central decisions embodied in successive five year plans targeted increased steel production levels. The resulting rise in steel production allowed the Soviet Union to maintain its position as the world's leading steel producer, held since 1973. The second largest steel producer among the CPEs, China, increased its annual steel production three-fold from 1970 to 1990. During this period, these two countries alone added 87 million metric tons to their annual steel production. Primarily as a result of these developments, the share of world steel produced by centrally planned economies increased from 30 percent to 37 percent during this period.

Capacity Trends and Implications

The preceding discussion on production highlighted key developments in the evolution of global steel supply patterns; an examination of global steelmaking capacity is needed to complete the picture. Many of the problems experienced by steel producers in the 1970s and 1980s are related to the problem of excess capacity that developed when increases in steelmaking capacity exceeded those in steel consumption. The problem was particularly acute in industrialized countries, though developing countries also experienced problems. CPE countries appear to have been less adversely affected by surplus steelmaking capacity.

The period before 1974 was one of optimism and steady capacity growth for the world steel industry. Steel was thought to be an industry with steady, long-term growth potential. Between 1975 and 1986, that optimism proved misplaced as steelmakers faced contraction and/or relatively slow growth in steel consumption. The optimism resulted in increases in Western world (industrialized and developing) steelmaking capacity through much of the 1970s. Capacity declined in industrialized countries after 1982, but it continued to climb in developing nations (figure 2-13a and figure 2-13b). Although the rate of expansion in Western world capacity slowed to 1.6 percent per year during 1975-83 (down from 4.1 percent per year during 1960-74), surplus capacity continued to accumulate. In 1982, capacity exceeded production by over 250 million metric tons (or by approximately 40 percent). Capacity utilization rates, which averaged 80 percent during 1960-74, remained below 75 percent during 1975-87.

Problems associated with excess capacity are compounded when steel companies maintain high operating rates in order to benefit from economies of scale (lower average costs of production). Because fixed costs are relatively high in an industry as capital intensive as steel,[25] it is often economical in the short term for steel companies to maintain high operating rates even when the market price is not high enough to cover the average unit cost of production. In such circumstances, high operating rates at least enable the firm to partially recover initial investment costs or other overhead.

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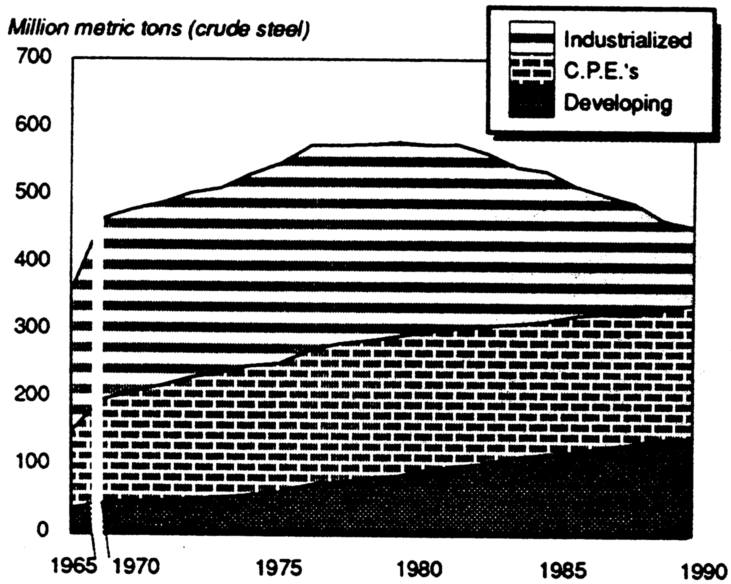
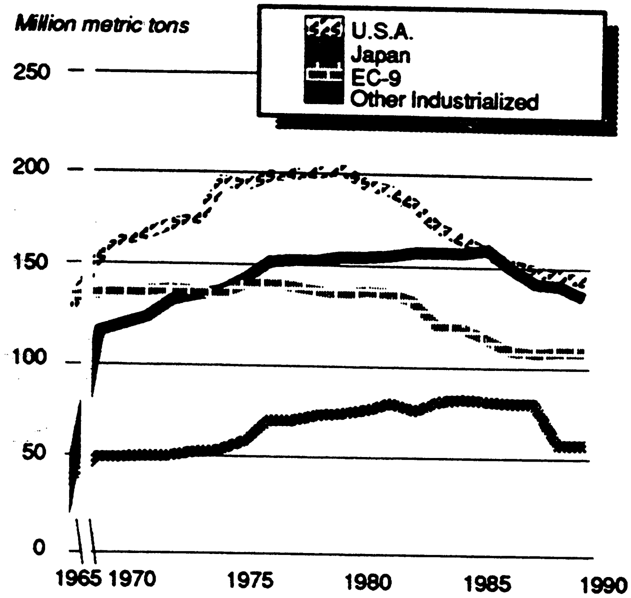
[25] The percentage of costs that are fixed for the U.S. steel industry is approximately 23 percent. Steel industries in many other countries are estimated to have higher ratios of fixed costs: Japan (29 percent), Korea (32 percent), and Brazil (39 percent). Putnam, Hayes, and Bartlett, *Economics of International Trade in Steel: Policy Implications for the United States*, (Newton, Mass: Putnam, Hayes and Bartlett, 1977), pp. 11-25. For estimates of fixed cost ratios, see The WEFA Group, *U.S. & World Executive Steel Report*, (Apr. 1, 1991), p. 39.

Figure 2-13a
Global crude steelmaking capacity, 1965-90: Industrialized world capacity falls in 1980s, steady growth in other regions



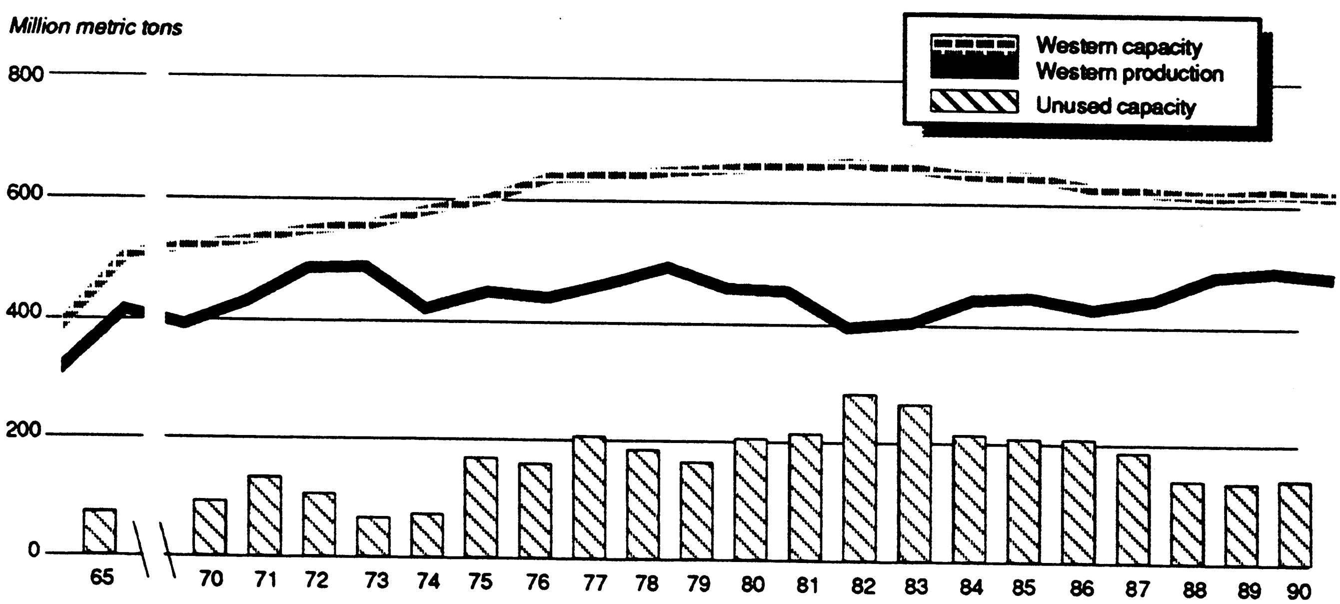
Source: PaineWebber, *Global Steelmaking Capacity Track* Core Report BB, (January, 1988) and Steel Strategist #17, (February, 1991).

Figure 2-13b
Industrialized world crude steelmaking capacity, 1965-90



Source: PaineWebber, *Global Steelmaking Capacity Track* Core Report BB, (January, 1988) and Steel Strategist #17, (February, 1991).

Figure 2-13c
Western world capacity and production, 1965-90: Gap narrows after 1982



Source: International Iron and Steel Institute (production) and PaineWebber (capacity).

The costs of surplus capacity during the 1970s and 1980s were great. Steel prices faced strong downward pressure, making it inevitable that large sectors of the industry would face substantial financial losses. In countries where the steel industry was owned by the state, the cost to taxpayers during these crisis years was often substantial. In the European Community, for example, governmental steel assistance during 1980-88 totalled over $45 billion, which included assistance aimed at aiding continued operation, as well as assistance designed to address "emergency" needs. (See section on government policy in chapter 3). In many developing countries that relied on steel industry exports, the lower steel prices reduced foreign exchange earnings.

The U.S. steel industry and steelworkers were significantly affected by the surplus capacity problem. Steel companies around the world, facing weak domestic markets, sought new markets for their products. As a large and relatively open market dominated by high cost integrated producers, the United States was an attractive alternative market. The resulting surge of predominantly low-cost steel imports compounded problems already experienced by U.S. steelmakers.

Adjustment programs in industrialized countries resulted in significant capacity reduction. Combined with strong demand during 1988-89, these programs reduced the imbalance between production and capacity among industrialized and developing countries to approximately 130 million metric tons (figure 2-13c). With respect to CPE countries, the imbalance is an estimated 17 million metric tons in the case of Eastern Europe, or 42 million metric tons if the Soviet Union is included.[26]

[26] PaineWebber, *Global Steelmaking Capacity Track* (January 1988), and *Steel Strategist #17* (Feb. 1991), and International Iron and Steel Institute, *Steel Statistical Yearbook* (1988, 1989).

Factors Underlying Excess Capacity

Given the major difficulties created by excess steelmaking capacity, it is worth exploring how the global industry came to such a crisis. Three factors stand out as primary causes: overly optimistic demand forecasts, government intervention, and, to a lesser extent, advances in steel process technology. An examination of demand forecasts made in the 1970s reveal consistent overestimation of future steel consumption. Forecasters closely linked projections to historical patterns, which indicated that market downturns, such as the one in the mid-1970s, were only temporary interruptions in the trend of continued growth in steel demand and production. Forecasts made during the 1970s for the year 1985 (table 2-8) put global steel consumption in a range from 890 million metric tons to more than 1.1 billion metric tons; actual consumption was 720 million metric tons. Because investment decisions rely in part on forecasts of steel demand, such overestimation likely contributed significantly to excess steelmaking capacity.

Government contributions to excess capacity took a variety of forms. In Japan, a system of guidelines administered by the Ministry of International Trade and Industry diminished many of the risks of expanding capacity. Production restraints kept prices stable during periods of economic downturn and imports were effectively limited by the distribution network.[27] Some 93 million metric tons of capacity were added between 1965 and 1974.

Government assistance, combined with price and production controls, also supported the addition of new capacity in the European Community, and allowed inefficient firms to remain in operation at a time when production and consumption were falling. After a decade of restructuring efforts and capacity reductions, European industry sources indicate that excess capacity in 1989 was close to 10-15 million metric tons.[28]

[27] Howell, *Steel and the State*, pp. 215-221.
[28] Interviews by USITC staff, November 1989, Munich, Germany.

Table 2-8
Global steel forecasts for consumption in 1985, by selected organization

Source	*Global steel consumption forecast for 1985*	*Year forecast made*
	Million metric tons	
International Iron and Steel Institute	1,144	1972
United Nations	1,069	1976
Wharton	896	1977
Citibank	890	1978
International Iron and Steel Institute	1,019	1978
Fordham University	920	1979

Source: International Iron and Steel Institute; United Nations Industrial Development Organization, International Center for Industrial Studies; and Steel Service Center Institute, "Center Lines," vol. XIV, May, 1979.

In several developing countries, such as Korea, Brazil, and Indonesia, national self-sufficiency in steel was a goal that could not be rapidly achieved without state intervention. Private companies lacked sufficient capital resources to invest in new facilities, especially in a market environment often characterized by uncertainty. The situation was exacerbated in the 1970s by the growing size (and hence cost) of steelworks that were considered internationally competitive.[29] For state policymakers, however, support of the steel industry was a way of promoting a variety of national and regional objectives including increased employment, development of downstream industries (i.e. forward integration), decreased reliance on imports (and reduced foreign exchange expenditures), increased exports and foreign exchange earnings, and national security. State support for the steel industry in several developing nations (including Brazil, India, Korea, and Taiwan) contributed to the addition of nearly 100 million metric tons of new capacity between 1970 and 1990.

Finally, advances in steel technology compounded the problems associated with excess capacity by increasing the potential output of existing facilities. As discussed in chapter 3, new process technologies at the hot end of steelmaking facilities (the blast and steelmaking furnaces) enabled steelworks to increase their throughput of crude steel. For example, the tap-to-tap time of electric steelmaking furnaces (i.e. the amount of time required to prepare and pour a batch of steel) improved with the introduction of oxygen-blowing techniques. At integrated mills, the use of continuous casting as opposed to the traditional ingot teeming method increased the production of semifinished steel. In addition, new technologies for the rolling of steel increased finished steelmaking capacity.

Global Steel Trade

After expanding during the 1960s and 1970s, world trade in steel has remained fairly constant throughout the past decade. As a result, steel trade has not kept pace with trade in manufactured goods as a whole. Part of the reason for this relative slowdown in steel trade is that developing and CPE nations have become more self-sufficient in steel; trade restraints implemented by a number of countries were also important factors in this regard. Nevertheless, trade remains an essential element of the global steel industry. Below is a discussion of the principal aspects and underlying causes of major shifts in steel trade patterns.

Shifts in Trade Volume

Between 1960 and 1974, world exports increased at an average annual rate of 9.5 percent; since then the rate has slowed to 2.6 percent (through 1989), peaking in 1985 at 170 million metric tons. During 1970-89, exports fell in the United States, grew moderately in the EC and Japan, and grew dramatically among principal steel-producing developing countries (Brazil, People's Republic of China, India, Korea, Mexico, and Taiwan). With respect to share of world exports, the EC countries have dominated steel trade of industrialized nations since the 1960s, although their share of total world exports declined from 49 percent during 1970-74 to 42 percent during 1988-89 (table 2-9). Approximately one half of those exports are shipped to other EC countries.

If intra-EC trade is excluded, the EC share of world exports fell from 33 percent during 1970-74 to 25 percent during 1985-89 (table 2-10). Exports from Japan, which surpassed the level of EC bloc exports in 1971 to make Japan the leading steel exporter, fell slightly during 1977-82 as a result of increased competition from exports of developing nations and non-EC Western European nations. After 1985, Japan's share of world exports fell even more precipitously as the yen appreciated and Japanese domestic market conditions strengthened. U.S. exports, already small in the early 1970s, declined to one percent of world exports during 1985-89. More recently however, favorable exchange rates and strong foreign markets boosted the U.S. export share to 2.5 percent in 1989. Among principal developing countries, the pace of export growth has been strong. Average annual exports during 1985-89 were ten times larger than in 1970-74, and developing country share of world exports grew from 1.6 to 10.7 percent during these periods.

With respect to imports (table 2-11), the United States has been the single largest market for steel and is the only major industrialized country that is a consistent net importer of steel. In 1984, when imported steel accounted for over a quarter of domestic steel consumption, U.S. imports comprised a record 15 percent of total world imports; changing market conditions and trade restraints contributed to a decline to 10 percent by 1989. EC countries account for the largest share of total world imports, although the majority of these imports (over 70 percent) originate from within the EC. If intra-EC trade is excluded (table 2-12), EC imports are significantly less than U.S. imports. Japanese imports, despite substantial increases since 1985, are still relatively small, accounting for 4 percent of world imports during 1985-89. Developing nations as a whole have imported increasing amounts of steel, accounting for 26 percent of world imports in 1989, compared to 19 percent in 1971.[30]

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[29] The success of the Japanese industry, which had built very large blast furnace and steelmaking facilities, led many to suspect larger facilities were optimal in terms of efficiency. Robert W. Crandall, *The U.S. Steel Industry in Recurrent Crisis*, (Washington, DC: The Brookings Institution, 1981), p. 14; Donald F. Barnett and Louis Schorsch, *Steel: Upheaval in a Basic Industry*, (Cambridge, Massachusetts: Ballinger, 1983), p. 166.

[30] Calculated from International Iron and Steel Institute, *Steel Statistical Yearbook*, various issues.

Table 2-9
Steel mill products: Average annual exports, by country or region, by specified period, including intra-EC trade, 1970–89

Period	*United States*	*EC–12*[1]	*Japan*	*Principal steel-producing developing countries*[2]	*Other*	*World*
	1,000 metric tons					
1970–1974	4,171	52,677	23,821	1,737	24,263	106,669
1975–1979	2,440	59,038	31,970	3,966	32,251	129,665
1980–1984	2,028	63,369	29,919	11,344	37,821	144,480
1985–1989	1,758	69,386	25,727	17,678	50,201	164,750
	Percent of world exports					
1970–1974	3.9	49.4	22.3	1.6	22.7	100.0
1975–1979	1.9	45.5	24.7	3.1	24.9	100.0
1980–1984	1.4	43.9	20.7	7.9	26.2	100.0
1985–1989	1.1	42.1	15.6	10.7	30.5	100.0
	Percent of shipments[3]					
1970–1974	4.4	44.2	28.8	5.4	([4])	20.8
1975–1979	2.9	51.3	35.1	8.3	15.6	23.8
1980–1984	3.0	57.1	32.1	15.7	17.2	25.6
1985–1989	2.6	59.6	26.6	17.0	20.6	26.2

[1] Includes all twelve countries for all years.
[2] Includes Brazil, Peoples Republic of China, India, Republic of Korea, Mexico, and Taiwan.
[3] Derived by the staff of the International Trade Commission.
[4] Not available.

Source: Compiled from statistics of the International Iron and Steel Institute and the U.K. Iron and Steel Statistics Bureau, except as noted.

Table 2-10
Steel mill products: Average annual exports, by country or region, by specified period, exluding intra-EC trade, 1970–89

Period	*United States*	*EC–12*[1]	*Japan*	*Principal steel-producing developing countries*[2]	*All other*	*World total*
	1,000 metric tons					
1970–74	4,171	26,837	23,821	1,737	24,263	80,829
1975–79	2,440	36,418	31,970	3,966	32,251	107,045
1980–84	2,028	34,709	29,919	11,344	37,821	115,820
1985–89	1,758	31,446	25,727	17,678	50,201	126,810
	Percent of world exports					
1970–74	5.2	33.2	29.5	2.1	30.0	100.0
1975–79	2.3	34.0	29.9	3.7	30.1	100.0
1980–84	1.8	30.0	25.8	9.8	32.7	100.0
1985–89	1.4	24.8	20.3	13.9	39.6	100.0
	Percent of shipments[3]					
1970–74	4.4	22.5	28.8	5.4	([4])	16.1
1975–79	2.9	28.2	35.1	8.3	15.6	18.9
1980–84	3.0	31.3	32.1	15.7	17.2	20.5
1985–89	2.6	27.0	26.6	17.0	20.6	20.2

[1] Includes all twelve countries for all years.
[2] Includes Brazil, Peoples Republic of China, India, Republic of Korea, Mexico, and Taiwan.
[3] Derived by the staff of the International Trade Commission.
[4] Not available.

Source: Compiled from statistics of the International Iron and Steel Institute and the U.K. Iron and Steel Statistics Bureau, except as noted.

Table 2-11
Steel mill products: Average annual imports, by region of origin, by specified period, including intra-EC trade, 1970-89

Period	United States	EC-12[1]	Japan	Principal steel-producing developing countries[2]	All other	World total
	1,000 metric tons					
1970-74	14,274	36,300	143	8,505	47,384	106,606
1975-79	15,044	39,408	464	13,115	61,805	129,835
1980-84	16,952	40,798	2,296	15,148	69,312	144,506
1985-89	18,934	50,017	5,086	22,874	68,150	165,060
	Percent of world imports					
1970-74	13.4	34.1	0.1	8.0	44.4	100.0
1975-79	11.6	30.4	0.4	10.1	47.6	100.0
1980-84	11.7	28.2	1.6	10.5	48.0	100.0
1985-89	11.5	30.3	3.1	13.9	41.3	100.0
	Percent of apparent consumption					
1970-74	13.5	35.3	0.2	4.2	(3)	20.8
1975-79	15.7	41.3	0.8	23.0	26.2	23.9
1980-84	20.6	46.1	3.5	20.0	27.6	25.6
1985-89	22.2	51.5	6.7	21.0	26.0	26.2

[1] Includes all twelve countries for all years.
[2] Includes Brazil, Peoples Republic of China, India, Republic of Korea, Mexico, and Taiwan.
[3] Not available.

Source: Compiled from statistics of the International Iron and Steel Institute and the U.K. Iron and Steel Statistics Bureau.

Table 2-12
Steel mill products: Average annual imports, by country or region, by specified period, excluding intra-EC trade, 1970-89

Period	United States	EC-12[1]	Japan	Principal steel-producing developing countries[2]	All other	World total
	1,000 metric tons					
1970-74	14,274	10,460	143	8,505	47,384	80,766
1975-79	15,044	12,588	464	13,115	61,805	103,015
1980-84	16,952	12,138	2,296	15,148	69,312	115,846
1985-89	18,934	12,075	5,086	22,874	68,150	127,118
	Percent of world imports					
1970-74	17.7	13.0	0.2	10.5	58.7	100.0
1975-79	14.6	12.2	0.5	12.7	60.0	100.0
1980-84	14.6	10.5	2.0	13.1	59.8	100.0
1985-89	14.9	9.5	4.0	18.0	53.6	100.0
	Percent of apparent consumption					
1970-74	13.5	10.2	0.2	4.2	(3)	16.1
1975-79	15.7	13.2	0.8	23.0	26.2	18.9
1980-84	20.6	13.7	3.5	20.0	27.6	20.5
1985-89	22.2	12.4	6.7	21.0	26.0	20.2

[1] Includes all twelve countries for all years.
[2] Includes Brazil, Peoples Republic of China, India, Republic of Korea, Mexico, and Taiwan.
[3] Not available.

Source: Compiled from statistics of the International Iron and Steel Institute and the U.K. Iron and Steel Statistics Bureau.

Export Markets Increase in Importance

The shortcoming of the figures on trade volume is that they do not reveal the extent to which the level of exports reflects the expansion or contraction of the industry. In this regard, contrasting the growth in exports to that of production is more instructive. The 9.5-percent rate of export growth during 1960-74 was considerably higher than the 5.4-percent growth rate for production. Similarly, the 2.6-percent annual growth in trade during 1975-89 was nearly twice as rapid as the 1.4-percent annual production increase.

As a consequence of the more rapid growth of exports compared to production, the share of steel production that was exported increased (figure 2-14). As the level of exports increased from 117 million metric tons in 1970 to 214 million metric tons in 1989, the percent of global steel production that is exported increased from 20 percent to 27 percent. In other words, export markets increased in importance for steel-producing nations. Since 1985, however, the share of world steel production that is exported has fallen.

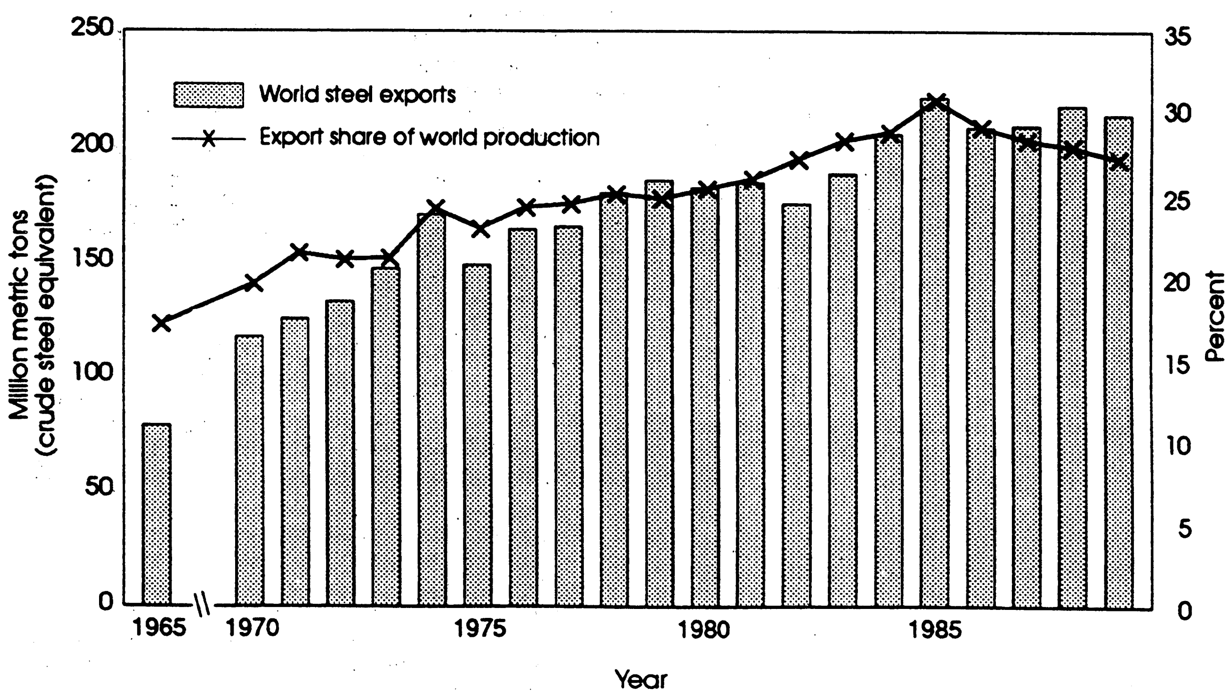
The Relative Position of Steel Trade

Despite the general upward trends in steel trade through 1985, trade in steel has not grown as rapidly as it has for manufactured goods as a whole, nor for the average of all exports. In fact, by value, the percent of total exports comprised by steel has declined (table 2-13); the same is true of the ratio between steel exports and manufacturing exports. This decline is sharpest among industrialized countries.

Several factors account for the trends in steel trade discussed above. Some factors promoted trade, others limited it. As mentioned earlier, the increased self-sufficiency of developing and CPE nations in steel production limited export markets for steelmakers in industrialized countries. Globalization in the industry also appears to have diminished trade. As the steel industry globalized during the 1980s, in many cases foreign investment became an alternative to trade. For example, as steelmakers from the world's leading steel exporter, Japan, invested in the U.S. steel industry after 1984, they began to increasingly use steel produced in the United States as opposed to steel produced in Japan to meet the needs of their customers located in the United States (see section on globalization in chapter 3).

In addition, trade policies adopted in the United States and Europe, particularly the programs of voluntary restraint agreements (VRAs), limited exports to these markets. Although countries subject to U.S. VRAs have generally not filled their export ceilings since 1988, they did in earlier years (see appendix E).

Figure 2-14
World steel exports. 1965-89
Strengthen during 1970s, stagnate after 1985



Source: International Iron and Steel Institute.

Table 2-13
Iron and steel: Export value as a percent of total manufactured goods' export value, and as a percent of total export value, by specified country grouping, by specified time period

Country group	*1973-77*	*1978-82*	*1983-87*
		Percent	
Industrialized countries:			
Steel exports/manufactures exports	8.9	7.1	5.4
Steel exports/total exports	6.3	5.2	4.0
Developing countries:[1]			
Steel exports/manufactures exports	4.2	4.4	4.4
Steel exports/total exports	1.3	1.1	1.6
Centrally planned economies:			
Steel exports/manufactures exports	9.6	8.3	8.1
Steel exports/total exports	5.5	4.4	4.1
World:			
Steel exports/manufactures exports	8.5	7.0	5.5
Steel exports/total exports	4.9	4.0	3.5

[1] For years 1974-78, exports from OPEC countries not included in developing country totals.

Source: Compiled from statistics in GATT, *International Trade,* various issues.

Of the factors that have tended to increase trade, reduced tariff rates on steel mill products appear to have been significant. International negotiations during the Kennedy Round (1963-67) and Tokyo Round (1975-79) of the General Agreements on Tariffs and Trade resulted in lower tariffs on steel products for many countries (see tables 3-4 and 3-5 in government policy section of chapter 3). Between 1970 and 1990, for example, the tariff imposed by industrialized countries on hot-rolled sheet fell by between one-third and one-half. Among certain developing countries, such as Brazil, Korea and Mexico, tariff reductions implemented in the past few years have been even more dramatic.

Another factor affecting trade has been the specialization of production in specific grades or products. Specialization results in trade even between countries that produce sufficient crude steel to meet internal demand. If a country has the capacity to roll only flat products, it will need to import its nonflat steel, even if it melts sufficient crude steel to meet internal demand. Trade resulting from specialization appears particularly applicable to trade within the EC, where some of the largest steel companies are pursuing a strategy of specialization; British Steel, for instance, has developed a focus on structural steels, and Usinor-Sacilor has recently demonstrated a focus on stainless steel and an assortment of very narrowly-defined products.

Despite all the factors either expanding or limiting trade (or perhaps because of them), essential features of the global trade in steel have remained unchanged since 1970. The principal exporters in the Western World continue to be Japan and the EC, whereas the United States and most developing nations (in spite of developments in Korea, Brazil and a small number of other nations) are still major net importers.

Employment Trends

One of the most important consequences of the geographic shifts in production and consumption has been a sharp decline in the number of workers employed in the steel industries of industrialized countries. At the same time, employment in the steel industry rose rapidly in developing countries (including China) and modestly in Eastern Europe and the Soviet Union. The average annual growth rate in employment levels during 1970-87 was as follows:

Country/region	*Percent*[1]
Industrialized countries	-3.0
Developing countries	[2]5.9
Eastern Europe and the the Soviet Union	0.8

[1] The employment statistics correspond to International Standard Industry Classification (ISIC) 37, basic metal industries, which encompasses ferrous and non-ferrous metals basic industries. Calculated from statistics of United Nations. *Yearbook of Industrial Statistics,* Vol. I., various issues.
[2] Reflects 1970-86 period only.

In the case of the developing countries, manpower increases were needed to keep pace with the increased demand for steel. Because steel plants in developing countries tend to be more labor intensive than those in industrialized countries, employment levels rose along with capacity and production. As a result, the importance of steel workers as a component of the labor force increased during this period.

Among industrialized countries, two factors contributed to diminished employment levels. First, the decline in steel consumption and the increase in steel imports forced producers to cut back capacity and production, and hence, employment. Second, as these industries adjusted, they often modernized remaining facilities by adopting labor-saving technology. Technology has improved efficiency in almost all parts of the iron and steelmaking process, reducing the manhours required to produce a ton of steel. One study has estimated that the two factors have contributed more or less equally to the decline.[31]

The reductions in the work forces in industrialized countries in many cases has been dramatic. In the United States and the United Kingdom, for example, the labor force declined at an average annual rate of 10.0 and 5.6 percent, respectively, during 1970-87. The French and German industries also faced significant reductions in employment, whereas the Japanese industry faced less sizeable cutbacks.

As the size of the steel labor force has fallen, so has the importance of the industry as an employer. This may have important implications. One steel industry analyst speculated that the declining role of the steel industry as an employment source has diminished government interest in the industry, thereby reducing the political sensitivity of many of the policy issues that surround the industry.[32]

Financial Experience

Like employment, financial performance reflects the effects of shifts in supply and demand patterns discussed earlier in the chapter. Examining key financial results reveals the impact these shifts have had on the steel industries in both industrialized and developing countries.[33]

Not surprisingly, many steelmakers, particularly those in the United States and Europe, experienced substantial financial losses for several years during the 1975-87 period. For example, Usinor-Sacilor of France was unprofitable throughout this period; British Steel was profitable only after 1984, and the steel operations of USX were profitable in only three years (1975, 1976, and 1981). Overall financial performance was at its lowest point in 1982; Western world steelmakers lost on average about $39 (before taxes) for every metric ton of steel shipped.[34]

A comparison of pre-tax profit as a percent of sales (table 2-14) or, alternatively, operating profit as a percent of sales (table 2-15)[35] among countries shows that after a few years of making relatively small profits in the early 1970s, steelmakers in Europe consistently lost money over the next decade. Only German companies were able to record profits during this period. Losses in the U.S. steel industry occurred during a briefer period (1980-86), though were still large, representing 21 percent of sales in 1982. Several U.S. steelmakers, most notably LTV Corporation and Wheeling-Pittsburgh Steel Corporation, were forced to file for protection under chapter 11 of federal bankruptcy laws.[36] Japanese companies, on the other hand, lost money during only two years; at approximately one percent of sales, the losses were relatively small. Steel companies in Australia and Canada similarly did not experience the large financial losses that many of their competitors faced.

Among developing countries, the experience is diverse. In general, the steel industries in Asia (Korea, Taiwan, and India) recorded better financial performances than those in Latin America. For example, Korea's POSCO has consistently been profitable, whereas Brazil's CSN has lost money every year since 1979.

The rebound in global steel demand in 1988 enabled most loss-making companies to return to profitability. U.S. companies recorded an income-to-sales ratio of 9 percent in 1988, the highest since 1974, and French and British steelmakers returned to profitability as well.[37]

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[31] United Nations Economic Commission for Europe, *The Importance of the Iron and Steel Industry for the Economic Activity of ECE Member Countries*, 1989, p. 16.

[32] Rod Beddows, "Globalization in the World Steel Industry," presented at Globalization of Steel conference, Atlanta, GA, Feb. 25-27, 1990.

[33] Because indicators of financial performance do not generally apply to steelmakers in CPE countries, this section focuses on steelmakers in industrialized and developing countries.

[34] World Steel Dynamics, *Financial Dynamics of 61 International Steelmakers* Core Report LL, (September 1990), p. 2-83.

[35] Operating profit excludes financial costs (interest and depreciation) as well as extraordinary items (such as write-offs for plant closures).

[36] LTV Corporation filed for chapter 11 bankruptcy in 1986 and continues to operate under its protection. In May 1991, the company filed a reorganization plan with the U.S. Bankruptcy Court in New York and subsequently sold its aerospace and defense division to pay off its pension debt. Wheeling-Pittsburgh filed for protection under chapter 11 in 1985; its reorganization plan was approved in January 1991. A third integrated mill, Sharon Steel, emerged from chapter 11 in early 1991, after operating under protection since 1987. Several other mills also filed for protection during the crisis period, including: Phoenix Steel (1983 and 1987), Eastmet (1985), Roblin Steel (1985), Enduro Steel (1986), Lone Star Steel (1989), and Mercury Stainless (1991).

[37] The return to profitability of British Steel and Usinor-Sacilor (France) were greatly facilitated by debt forgiveness. In France, the state announced in 1986 that it would convert $7.3 billion in loans into equity shares. In the United Kingdom, the government wrote off $8.4 billion of British Steel's debt and public dividend capital in 1981 and another $1.8 billion in 1982. Howell, *Steel and the State*, pp. 140, 166-7.

Table 2-14
Average pre-tax income as a percent of sales for steel companies, by selected country, 1972-89

Country/region	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
United States	5.2	7.5	10.8	4.5	2.4	-0.5	2.5	2.7	-1.1	2.5	-21.5	-10.3	-4.0	-4.5	-4.7	2.9	9.1	6.8
Japan	2.5	5.1	3.5	0.0	1.7	1.1	4.2	8.5	7.4	4.5	1.1	-0.8	2.9	1.1	-1.3	3.6	9.7	(1)
Germany	1.6	2.6	3.5	2.4	1.9	0.7	-1.5	1.3	-0.3	-0.7	0.0	-3.4	-0.8	-0.9	0.0	-2.7	4.2	(1)
France	-1.9	2.2	1.0	-15.8	-8.5	-22.2	-13.2	-8.2	-9.6	-20.5	-23.9	-32.1	-32.4	-6.8	-3.0	-0.2	12.2	(1)
United Kingdom	0.6	2.8	3.4	-11.6	-4.6	-17.4	-9.9	-17.8	-22.4	-8.7	-16.3	-6.3	-6.6	1.8	7.7	14.4	15.9	(1)
Canada	9.4	12.9	14.1	7.5	4.7	4.7	8.1	11.3	8.8	10.2	-4.7	-1.9	3.9	5.6	3.5	5.9	8.0	5.4
Brazil	12.1	12.3	12.8	6.5	2.0	6.1	0.6	-13.6	-1.7	-20.9	-36.8	-37.6	-32.4	-78.4	-35.3	-73.9	-95.4	(1)
Korea	(2)	11.4	34.7	9.5	13.1	9.7	6.6	6.3	1.4	5.9	8.7	9.2	12.9	9.1	8.5	4.6	14.4	4.1
Industrialized World	3.1	5.5	6.3	0.2	0.6	-3.1	-0.1	1.9	-1.6	-1.0	-8.9	-7.0	-2.0	-1.2	-1.5	2.4	9.0	(1)
Developing world	6.0	1.4	4.4	0.2	1.1	1.4	2.0	2.4	5.6	1.2	-6.3	0.3	6.2	-4.7	1.7	-5.4	3.5	(1)

[1] Not available.
[2] Not applicable.

Note.—Figures represent aggregate of ratios only for major companies in each country or region.

Source: World Steel Dynamics, *Financial Dynamics of 61 International Steelmakers*, Core Report Y (June, 1985), p. 2-101, and Core Report LL (September, 1990), p. 2-99.

Table 2-15
Average operating earnings as a percent of sales for steel companies, by selected country, 1972-89

Country/region	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
United States	7.1	9.0	12.0	5.9	4.0	1.3	4.1	4.1	0.4	3.8	-18.2	-6.9	0.6	-1.5	-1.8	5.2	10.6	8.4
Japan	10.4	11.8	10.2	8.3	10.7	10.7	12.4	16.1	15.8	12.0	9.1	7.9	10.7	8.9	6.8	10.1	14.7	(1)
Germany	3.7	4.9	6.1	4.7	4.2	3.5	1.1	4.0	3.1	3.8	4.3	-0.2	2.0	1.4	2.0	-0.9	5.8	(1)
France	2.1	9.1	7.6	-6.1	1.2	-10.3	-6.1	-2.2	-3.6	-11.6	-13.9	-22.9	-24.5	-3.2	2.3	4.7	16.6	(1)
United Kingdom	3.7	5.9	6.6	-6.8	1.2	-10.8	-3.2	-11.4	-15.8	-5.2	-12.5	-4.1	-4.4	3.3	8.3	14.9	16.2	(1)
Canada	11.5	14.7	15.8	10.6	9.2	10.4	12.7	14.6	11.9	13.5	-0.7	2.2	7.2	8.7	6.9	8.9	11.2	8.9
Brazil	15.4	16.3	18.3	14.1	14.0	15.9	8.9	-8.0	5.2	-8.3	-17.7	-8.1	-7.2	-54.3	-5.5	-54.2	-73.4	(1)
South Korea	(2)	17.7	37.5	15.2	19.7	16.8	15.9	17.5	14.0	17.8	15.9	15.3	17.1	12.8	12.2	9.4	18.7	8.3
Industrialized World	7.1	9.3	9.9	4.6	5.6	2.6	9.6	11.2	13.6	10.0	2.4	12.0	18.1	9.1	10.1	1.0	7.9	(1)
Developing World	10.1	6.1	10.8	8.5	9.4	9.8	4.9	6.4	4.2	4.3	-3.0	-1.1	3.6	3.5	3.5	6.5	12.1	(1)

[1] Not available.
[2] Not applicable.

Note.—Figures represent aggregate of ratios only for major companies in each country or region.

Source: World Steel Dynamics, *Financial Dynamics of 61 International Steelmakers*, Core Report Y (June, 1985), p. 2-102 and Core Report LL, (September, 1990), p. 2-100.

CHAPTER 3
THE COMPETITIVE ENVIRONMENT, 1970-91

This chapter analyzes issues important to understanding the international steel industry. Some of these issues involve actions taken by the industry itself, such as the globalization of the industry through cross-border investment and the development and implementation of new technology. Others involve actions taken by governments, in the form of policies related to trade, subsidies, and the environment. A final issue involves a macroeconomic factor affecting the industry, exchange rate changes. Each of these issues affects the competitive environment in which steel firms operate. The discussion in this chapter supports the subsequent analysis contained in the competitive assessment chapter and the chapter presenting conclusions.

Globalization

The steel industry has historically had a global character in the sense that finished steel mill products, technology, and raw materials inputs have long been traded among nations. Until recent years, cross border ownership of steelmaking assets was relatively limited. This, however, has changed, as certain producers and steel traders have globalized their operations through the full or partial acquisition of assets that produce, process, and/or distribute steel. This section explores the nature and extent of the globalization that has and is occurring, and assesses its effects on the competitive environment.

Discussion of Findings

Extent and Reasons for Globalization

An examination of the nature and extent to which globalization of operations has occurred internationally reveals that Japanese companies have been at the forefront in this regard. While U.S. producers have not been active in pursuing foreign investment, they have, nonetheless, been significantly affected by it, since much of the foreign investment has been in the United States (table 3-1).

Table 3-1
Foreign joint venture activity, by investing country, by venture location[1]

Investing country	*Location of venture, by region*	*Number of ventures*
Canada	United States	7
France	United States	7
	Western Europe	6
	Asia	1
Japan	United States	29
	Western Europe	3
	Asia	3
	Latin America	2
South Korea	United States	2
	Western Europe	1
	Asia	1
United Kingdom	United States	4
	Western Europe	2
West Germany	United States	2
	Western Europe	2
	Eastern Europe	8
	Asia	2
	Latin America	2
Other countries[2]	United States	8
	Western Europe	6
	Eastern Europe	1
	Asia	3
	Latin America	2

[1] The relative investment activity in the United States may be somewhat overstated. Data for the United States include virtually all foreign investment in steelmaking facilities and much of the foreign investment in steel processing and distribution facilities, whereas data for foreign countries include significant foreign investment in such facilities that occurred between 1988 and the present time.

[2] Includes Austria, Brazil, Finland, Italy, the Netherlands, the Peoples Republic of China, Singapore, Spain, Sweden, Switzerland, Taiwan, and the United States.

Source: Compiled from information presented in table 3-2.

One of the reasons why many foreign steelmakers have moved to globalize their operations is that it enables them to provide more effective support to traditional customers who are demanding more responsive or customized service. In the case of the Japanese, interest in globalization also reflects an interest in maintaining close supplier relationships with clients that have established operations around the world. Other reasons for globalizing steelmaking operations include perceived cost advantages, partial protection against exchange rate variability, the circumvention of trade measures and tariffs, and improved distribution capabilities. The United States has participated in the globalization process as a recipient of foreign investment. U.S. steel companies have formed joint ventures with foreign companies and have taken on foreign steel producers as equity partners. These arrangements have given the U.S. steel industry improved access to capital and technology, and have helped it to enhance its international competitiveness.

A list of foreign investment projects worldwide and the apparent reasons for such investment are presented at the end of this section in table 3-2, which includes all of the foreign investment in U.S. steelmaking facilities and much of the foreign investment in U.S. steel distribution and processing operations. Also highlighted are significant cross-border joint ventures that have been formed outside of the United States during the past several years.

Effects of Globalization on the Competitive Environment

Implications for the International Industry

Globalization is likely to continue throughout the 1990s, and could have important implications. Possible results of globalization include:

- Containment of potentially excessive capacity expansion
- Elimination of redundant capacity
- Broadened access to raw materials, production technology, and capital
- Reduced government involvement
- Improved distribution capabilities
- Enhanced product quality
- Expansion of geographic markets
- Development of specialized, higher value-added niche markets

The continued internationalization of the steel industry could affect capacity by containing potentially excessive capacity expansion. Joint ventures that feature alliances between companies with similar product lines, for example, will likely lead to the reduction of overlapping capacity in preexisting and newly constructed facilities. In Europe, joint ventures and acquisitions among certain producers have reduced excess production of long products. Moreover, while capacity in steel processing facilities (e.g., cold-rolling and coating) may rise as industrialized countries move toward the production of higher value products, such increases will likely be smaller than would be the case in the absence of joint ventures. For example, the construction of overlapping capacity was reduced in the 1980s when six galvanizing lines were installed in the United States, five of these by joint ventures. According to one analyst, were it not for the joint ventures, new galvanizing capacity worldwide would likely have been much higher, since customer demands would have compelled each steel company producing sheets for the automotive industry to construct its own galvanizing lines.[1]

Future globalization could reduce government involvement in the steel industry, particularly in those countries where governments now provide significant funds in support of industry operations. Foreign steel companies are a viable alternative source for capital, and could displace state ownership in such countries, particularly to the extent that governments are anxious to withdraw their support.

With respect to international trade, the net effect of globalization is unclear. On one hand, trade will decline to the extent that imports are replaced by shipments from domestic facilities owned by foreign exporters. On the other hand, trade could increase if globalization results in an increase in specialization; under such conditions, countries would import the products that they no longer produce.

One analyst has suggested that the magnitude and direction of international trade will be closely tied to international joint ventures between industrialized and developing countries, particularly those focusing on the procurement of raw materials, such as coal, iron ore, and semifinished steel.[2] With respect to semifinished steel, the costs of replacing such major facilities as coke ovens and blast furnaces, particularly in the face of increasingly stringent environmental regulations, could pressure producers in industrialized countries to form joint ventures with developing countries for the acquisition of semiprocessed materials. Such joint ventures could result in increased trade of semifinished steel, while trade in finished products remained relatively stable.

Cross-border investments could also induce participating countries to reduce barriers to international trade. For example, if steelmakers in a country rely increasingly on partially advanced steel from other countries for their finishing operations, they might be less inclined to support actions that would interrupt the flow of such material. Cross-border

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[1] William T. Hogan, S.J., *Global Steel in the 1990s*, (Lexington, MA: Lexington Books, 1991), pp. 217-219.

[2] Ibid.

ventures could also reduce the filing of unfair trade cases and protectionist sentiments in general, by blurring the definition of "domestic" industry.

Finally, continued global linkups between producers will likely diminish disparities in the competitiveness of major steel-producing nations. Recipients of foreign investment should be able to improve product quality as they obtain expanded access to production technology and modernized facilities. In the area of customer service, where steelmakers exporting to foreign markets generally operate at a disadvantage, the increasing acquisition of distribution facilities abroad should enable foreign steelmakers to provide service more comparable to that provided by domestic producers, even for the most demanding foreign customers (e.g., the auto producers). The acquisition of foreign distribution facilities will allow steelmakers to reduce delivery lead times, expand product availability, and encourage closer collaborative relationships with consumers. Moreover, the establishment of foreign operations may enable firms to enhance economies of scale by spreading R&D and marketing costs among foreign and domestic operations. Economies may also accrue from greater product specialization and lower inventory costs.[3]

Implications for the U.S. Industry

In light of the continued globalization of steelmaking operations and a more internationalized marketplace, the competitiveness of the U.S. steel industry during the next decade will be determined primarily by relative U.S. production costs, service, and quality. The continued internationalization of major steel customers in the United States, such as the auto industry, will lead to increasingly globalized steel product standards and performance requirements.[4] Further foreign investment in the United States should aid producers and distributors in meeting the changing needs of the steel market through access to new technology and additional funds for modernization. Continued foreign investment could also improve customer service by broadening distribution outlets and strengthening steel delivery reliability as foreign companies acquire U.S. operations to become more proximate to their U.S. customers and to reduce transportation costs.[5] This, in turn, would likely put competitive pressure on U.S. firms to provide similar levels of service.

With respect to trade, increasing foreign investment in the United States could have a two-way effect. U.S. imports could grow as a result of increased linkage between U.S. finishing operations and foreign production of semifinished steel and/or hot-rolled bands. Conversely, other imports could decline as foreign producers with U.S. steelmaking facilities supply their U.S. customers with steel produced in U.S. facilities rather than with steel made in their plants at home.

The remainder of this section consists of an analysis of the characteristics and results of globalization in various regions of the world.

Developments in the United States

Most foreign investment in steelmaking operations has taken place in the United States. The formation of joint ventures provided U.S. steelmakers with greater access to capital and new technology necessary for modernization, and it provided new foreign partners increased access to the U.S. market and distribution network.

Small-scale foreign investment in the United States has been evident for several decades, with significant growth occurring during the 1980s. Initially, foreign capital went into the importation and distribution of steel and later into steel fabrication and production technology. In the early- to mid-1980s, some joint ventures were also designed to restart closed operations, thereby preserving employment; they provided funding for modernization, and, in one instance, enabled entry into new and higher value steel markets.[6]

During the past several years, foreign investment has continued to focus on specific operations or product lines, particularly for automotive applications. An industry spokesman noted that the presence of demanding Japanese auto transplants had caused domestic steelmakers to accelerate their capital improvements, largely through joint ventures with Japanese steelmakers, who injected both capital and

[3] "Globalization of Steel," *33 Metal Producing*, April 1990, p. 7.

[4] Rod Beddows, "Globalization in the World Steel Industry," presented at Globalization of Steel conference, Atlanta, GA, Feb. 25-27, 1990.

[5] Bob Boyle, "Foreign investment likely to grow," *American Metal Market*, Steel Service Center Supplement, May 14, 1990, p. 14A.

[6] For example, in 1984 and 1986, foreign investment in sheet and strip processors contributed to the formation of California Steel Industries (CSI) and USS-Posco Industries (UPI), respectively. CSI, a joint venture between Kawasaki Steel (Japan) and Compahnia Vale do Rio Doce (a state-owned Brazilian natural resources company), consists of the former rolling and finishing facilities of Kaiser Steel, located in Fontana, CA. Kaiser had closed the facilities in 1983, when its $233 million modernization program, costs associated with environmental regulations, and relatively high wage rates left the company with debts it could not support in the soft steel market of the early 1980s. UPI, a 50/50 partnership between USX and Pohang Iron and Steel Co. (Korea), was formed at USX's former rolling mill in Pittsburg, CA. The venture resulted in a modernization program exceeding $350 million designed to increase the quality of UPI's product. U.S. International Trade Commission, *The Western U.S. Steel Market: Analysis of Market Conditions and Assessment of the Effects of Voluntary Restraint Agreements on Steel-Producing and Steel-Consuming Industries*, investigation No. 332-256, USITC publication 2165, March 1989.

technology into the domestic industry.[7] One important consequence of Japanese investment is that, by 1992, the U.S. steel industry will have increased its combined galvanizing capacity by more than 30 percent.[8] The outcome of such investment has been that, in addition to being major competitors of the U.S. industry, the Japanese steelmakers have become principal partners in U.S. steel facilities.

During the past year, foreign investment from a growing number of countries has been directed toward a broad range of operations extending from the production of basic steel mill products to rolling, finishing, and distribution operations. Most new entrants appear to be European rather than Asian, as shown in table 3-2. In some instances, new facilities are being built, whereas other investments involve the acquisition of part or all of a company's existing steel production and/or distribution operations.

Several mutually beneficial reasons exist for the increasing number of joint ventures between U.S. and foreign steelmakers in the United States. U.S. steelmakers apparently enter such ventures because foreign companies offer the technology and capital necessary to enhance U.S. steelmaking operations, particularly in such high value markets as those for coated flat-rolled products and special quality bar. Foreign firms, in general, have found joint ventures an attractive means to supply traditional clients who have facilities in the United States, such as Japanese auto producers.[9] Other factors motivating the participation of foreign producers in the U.S. steel industry are exchange rate movements, which have made investment in the United States relatively inexpensive, and the existence of trade measures, such as the VRAs, that limit certain countries' exports of steel to the United States.[10]

A number of these factors, for example, influenced NKK's decision (Japan) to invest in National Steel Corp. An NKK official noted that "with fluctuating currency, shifting demand patterns and the establishment of Japanese manufacturing facilities in the United States, it was essential that we have an American partner to participate in the United States' substantial steel market, over the long term." The official's statement further noted that NKK is committed to improving National's operations by providing technology and substantial capital investments.[11]

Developments in Western Europe

Steelmakers in the European Community (EC) have a long history of owning distribution and steelmaking facilities in neighboring European countries and the United States (with distribution facilities predominating); however, during the past year steelmakers have more rigorously pursued globally focused corporate strategies in order to create production, marketing, and research and development synergies among all of their holdings.[12]

Within the EC, British Steel and Usinor-Sacilor have been the most active in forming cross-border ventures. One of British Steel's announced long-term goals is to acquire facilities in continental Europe and the United States partly to reduce its dependence on its home market, which accounts for about 64 percent of its sales.[13] In June 1990, British Steel purchased its first steelmaking facility in Continental Europe, Klockner-Mannstadt, a subsidiary of Klockner-Werke located in Trisdorf, Germany. The purchase should enable British Steel to broaden its market range beyond the United Kingdom, thereby improving its position in the European construction market.[14] In October 1990, British Steel purchased 45 percent of Aristrain (Spain), obtaining access to the Spanish construction market and to Aristrain's European distribution network. This agreement should give British Steel, Europe's largest structural producer, 30 percent of the European medium and heavy structural market.[15]

Usinor-Sacilor has followed a twofold policy with respect to its foreign ventures; it is designed to increase its downstream presence in steel processing and distribution and to improve its competitive position in higher value-added markets, such as those for stainless and coated steel. Usinor's distribution network currently distributes 30 percent of the steel Usinor produces, compared with 20 percent 2 years ago, which has reportedly enabled it to reduce delivery time and to meet customer specifications more precisely.[16] It also participates or is planning to participate in stainless steel operations on three continents. According to Usinor-Sacilor's president, the company's expansion

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[7] Officials of [* * *], interviews with ITC staff, Detroit, May 1991. For example, during 1989 and early 1990, eight steelmaking joint ventures involving six U.S. companies and seven foreign (primarily Japanese) companies were announced. A discussion of these various ventures is contained in U.S. International Trade Commission, *Steel Industry Annual Report on Competitive Conditions in the Steel Industry and Industry Efforts to Adjust and Modernize*, investigation No. 332-289, USITC publication 2316, September 1990, pp. 30-32.

[8] Tom Balcerek, "Japanese carmakers in U.S. bear down on steel quality," *American Metal Market*, Oct. 8, 1990, p. 4A.

[9] See, for example, Armco Inc. press release, "Armco and Kawasaki Steel Announce Joint Venture to Improve Specialty Carbon Steel Operations;" and The LTV Corp., *1989 Annual Report;* and Robert J. Darnall, "Global Opportunities, Creative Approaches," presented at Globalization of Steel conference, Atlanta, GA, Feb. 25-27, 1990.

[10] USITC, *Steel Industry Annual Report*, USITC publication 2316, p. 30.

[11] Yoshitaka Fujitani, "NKK is ready for international era," *American Metal Market*, Sept. 10, 1990, p. 17.

[12] Tom Balcerek, *American Metal Market*, "French steelmaker Usinor Sacilor cited for global gains," *American Metal Market*, Oct. 8, 1990, pp. 1,9.

[13] Charles Leadbeater, "Forging a bridge to Europe," *Financial Times*, May 22, 1990, p. 21.

[14] Ibid.; [* * *].

[15] "Aristrain confirms link-up with British Steel," *Metal Bulletin*, October 1990, p. 33.

[16] William Dawkins, "How the nightmare faded," *Financial Times*, Oct. 24, 1990, p. 11.

strategy is focused on niche markets rather than volume sales.[17] While making acquisitions and forming joint ventures, Usinor executives have made it clear that the company foresees the existence of only a handful of truly global steelmakers during the 21st century, and Usinor intends to be one of them. At the present time, Usinor derives 55 percent of its annual revenue from foreign sources.[18] In April 1989, Usinor acquired a 70-percent share in Germany's Saarstahl Volklingen, renaming the company Dillinger Hutte Saarstahl after merging with other German facilities previously owned by Usinor. The joint venture formed Germany's second largest steelmaker and the EC's largest producer of long products.[19]

Other important joint ventures in Western Europe include South Korean stainless steel producer Sammi Steel's acquisition of a 23.5 percent share in the United Kingdom in Aberneath Industries' stainless clad bar operation. The purchase will expand Sammi's product markets by allowing it to sell Aberneath products in countries where it already has distribution outlets such as the United States, Canada, and the Far East.[20] In 1990, C. Itoh, Japan's largest trading company, acquired a 5.1 percent share of Klockner-Werke, the German steel and engineering company.[21] The two companies also announced the formation in Germany of a joint venture to produce sheet for the automotive industry.[22] In addition, two of Europe's major producers of tool steel, Sweden's Uddeholm Steel and Austria's Boehler Steel (a subsidiary of Voest-Alpine), are planning to merge their operations, which could create the world's largest supplier of tool steel. The 1991 merger would complement the operations of both companies, expand marketing and distribution networks, and restructure production capacity to eliminate duplication and to enhance product development.[23]

Developments in Eastern Europe and the Soviet Union

Prior to the recent political and economic changes in Central and Eastern Europe, foreign investment in the region's steel industry was virtually nonexistent. Efforts to encourage such investment, however, are currently underway. The efforts include the passage of laws that specify the terms and conditions under which such investment can be made as well as broader efforts to develop more open market economies.

Hungary has apparently been the most active in seeking joint ventures for production and distribution of steel, having passed legislation to encourage foreign capital investment through tax incentives. It currently appears that there is little foreign participation in steel production and distribution in other Eastern European countries. Industry executives have noted that Poland and Czechoslovakia are apparently reluctant to restructure and modernize their steel facilities because of the possible social consequences (such as job losses).[24] Nevertheless, in Poland, certain foreign linkups are under consideration, primarily to acquire production technology. For example, continuous casting technology is being sought from U.S. companies, such as Inland Steel, to modernize the Sendzimir Iron and Steel Works located in Nowa Huta. Sendzimir is also contemplating a joint venture with a foreign (most likely West European) trading company to increase the company's exports.[25] Three Polish electric steelmakers have reportedly approached Japanese steelmaker Kyoei Steel for assistance in improving production efficiency, and Sumitomo Metal of Japan has offered to provide pollution control equipment for Poland's steel industry.[26] Similarly, there are several pending modernization contracts with foreign firms in Czechoslovakia, but it appears that no joint venture contracts have yet been concluded. In Romania, there is currently little foreign participation other than industry efficiency studies by management and technical experts.[27]

In the Soviet Union, foreign investment is hindered by numerous structural and procedural obstacles,[28] although there are presently about 39 joint ventures with foreign companies within the Soviet steel industry, according to Soviet sources. These joint ventures, which include both engineering and construction companies, focus primarily on the modernization of existing plants.[29] The Soviet Union's foreign trade organization, Promsyrioimport, handles most of the country's trade in steel products. The established relationship between Promsyrioimport and foreign buyers as well as other factors (cost considerations, the proximity of Soviet ports to

[17] Francis Mer, "The Future for Steel," presented at the 1990 Joint Convention of the American Institute for International Steel, Apr. 27, 1990.

[18] Dawkins, "How the nightmare faded,"; and Balcerek, "Usinor Sacilor."

[19] "Usinor takes 70% stake in Saarstahl," *Metal Bulletin*, Apr. 24, 1989, p. 23.

[20] "'Globalisation' catches on," *Metal Bulletin*, Dec. 31, 1990, p. 17.

[21] C. Itoh is a member of the same industrial group, the Dai-ichi Kangyo Bank group, as Kawasaki Steel. Through C. Itoh, Kawasaki is reportedly transferring galvanizing technology to Klockner.

[22] *Financial Times*, Oct. 26, 1990, p. 21.

[23] "'Globalisation' catches on," p. 17.

[24] [* * *]; Andrew Collier, "U.S. said set to give special trade status to Czechoslovakia," *American Metal Market*, Feb. 12, 1990, p. 9.

[25] Marilyn Werber, "Polish mill eyes West as savior," *American Metal Market*, Jul. 24, 1990, p. 1.

[26] "Poland: Lack of funds slow update," *Steel Times*, August 1990, p. 437.

[27] [* * *].

[28] U.S. International Trade Commission, *Survey of Views on the Impact of Granting Most Favored Nation Status to the Soviet Union*, investigation No. 332-280, USITC publication 2251, January 1990; U.S. International Trade Commission, *Summary of the Soviet Economy, Economic Reforms, and U.S.-Soviet Economic Relations*, vol. 3, USITC publication 2271, April 1990; and Marilyn Werber, "Investment in Russia Far Off?," *American Metal Market*, Dec. 19, 1990, p. 6.

[29] B.V. Molotilov, Q&A session at World Steel Dynamics, New York, NY, June 1990.

European customers, and a long-standing reluctance to maintain assets outside the Soviet Union) have precluded Soviet ownership of distribution or steelmaking facilities in Western Europe and limited Soviet ownership in Eastern Europe. Recently, however, the Soviet steel mill at Donetsk apparently formed a joint venture with a cold rolling mill in Bulgaria, in which Donetsk will supply slabs and receive cold rolled sheet.

Developments in Asia

Foreign investment in the Asian steel industry (primarily from other Asian countries) is increasingly in production and distribution facilities. Foreign investments in the region's steel industry take the form of joint ventures, technology sales, turnkey construction of facilities, and loans. The investment is designed to expand access to foreign markets; from the recipient's perspective, such investment provides access to technology as well as a means to increase the country's ability to supply its steel needs with domestic product rather than with imports. Three of the more active countries involved in this regard are Japan, Malaysia, and Taiwan.

Japan's investments in the steel operations of other Asian countries are widespread. Much of the investment has been in steel distribution facilities. Because Southeast Asia's expanding demand for steel represents a growing export market for Japan, Japanese trading companies (often acting in concert with associated steel companies) have invested in service centers in other Southeast Asian countries in order to process and distribute the growing volume of steel imported by these countries. However, Japan will not necessarily be the source of steel for their offshore processors; these manufacturers apparently tend to source steel on a competitive basis internationally.[30]

Japanese investment has also been focused on production facilities. In Malaysia, Japanese companies participated in the establishment in 1967 of the country's first integrated producer, Malaywata Steel, and they subsequently reinforced their presence through investment in a tin plate mill and Malaysia's first cold rolling mill.[31] The Japanese have also been active in steelmaking and finishing in Thailand through joint ventures established in the 1960s and 1970s; their investments continue today.[32] In addition, there has been some Japanese investment interest in Indonesia's state-owned Krakatau Steel, primarily in the form of feasibility studies and technical assistance. Involvement in Indonesia's distribution system has also grown. Two Japanese trading companies recently announced a significant investment in an operation that will supply Japanese auto and motorbike assemblers in Indonesia.[33]

Within the Taiwanese steel industry, most ventures with foreign steel producers have been related to steel production and the acquisition of raw materials. Taiwan's largest steel producer, the state-owned China Steel Corp. (CSC), has announced a joint venture to build a 2.5 million metric tons-per-year integrated steel mill in Malaysia that will begin production in mid-1995. CSC will own 40 percent of the mill; private Taiwanese investors, 9 percent; the Malaysian government, 30 percent; and private Malaysians, 21 percent.[34] CSC evidently decided to pursue the joint venture in order to share the costs associated with constructing the facility and acquiring new technology.[35] This conforms with CSC's announced goals to secure a supply of raw materials, expand international market share, obtain new technology, and increase profits.[36]

In the People's Republic of China (PRC), joint ventures with foreign partners have begun to emerge as a means of addressing the production problems associated with its outdated equipment and its inability to meet growing demand for high-quality carbon, alloy, and specialty steels.[37] The largest project is a proposed $400-million steel plant jointly owned by Taiyuan Iron & Steel Co. (TISCO), a major PRC producer of specialty steel, China International Trust & Investment Corp. (CITIC), and Krupp Stahl AG of West Germany. The country also plans to build an integrated steel mill capable of producing 3 million metric tons of steel annually with the assistance of Japanese metallurgical firms. Production will include products that the PRC now imports, such as steel plates, tubes, and specialty products.[38] Production of higher valued steel products is also the apparent goal of a joint venture being developed between Dongbu Steel (Korea) and a PRC development corporation.[39]

There is additional investment activity in the Asian region by non-Asian countries, particularly in facilities which produce higher value steel product. For example, France's Ugine Acier (a unit of Usinor-Sacilor), a major world stainless steel producer that has rapidly expanded its global operations, has expressed a strong interest in building Thailand's first stainless steel sheet mill. The facility would have an annual production capacity of 60,000 tons and would

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[30] Japanese trading company executives, interviewed by Commission staff, Tokyo, October 1989.

[31] WEFA Group, *Conquering World Steel Markets*, vol. III, pp. 2-114 to 2-116.

[32] One example is Kawasaki Heavy Industries' investment in Thai Tinplate Manufacturing. *Metal Bulletin*, Sept. 19, 1990.

[33] *Metal Bulletin*, Oct. 1, 1990, p. 19 and Dec. 4, 1989, p. 30.

[34] "China Steel eyes venture to build Malay mill," *American Metal Market*, Jan. 4, 1991, p. 1.

[35] "China Steel looks to offshore expansion," *Metal Bulletin Monthly*, May 1989, p. 51-7.

[36] Jo-Chi Tsou, presented at Steel Survival Strategies V, New York, NY, June 1990.

[37] Paul C. Ehrlich, "China eyes ventures with West Germany, Japan," *American Metal Market*, Aug. 6, 1990, p. 7.

[38] Ibid.

[39] "Dongbu Steel denies Chinese venture," *Metal Bulletin*, Nov. 26, 1990, p. 25.

finish imported hot-rolled stainless steel, with output directed toward the local market.[40]

In India, where state-owned steel mills account for about 54 percent of all steel production, increased demand has prompted government entity Steel Authority of India (SAIL) to seek additional foreign assistance to expand and modernize the five existing state-owned integrated plants and, perhaps, to assist in building two new greenfield facilities.[41] To date, the most active foreign participants in India's steel industry have been from West Germany, Japan and the USSR. Motivated by political considerations and a desire for increased market access, these countries have offered substantial funds, concessionary financing, or both, for the establishment or modernization of Indian steel plants.[42] India's only private integrated steel company, Tata Iron and Steel Co., has a joint venture with Timken Co. of the United States for production of tapered roller bearings in India, beginning in 1991.[43]

Developments in Latin America

Foreign investment in Latin America could grow as governments in certain countries attempt to sell their equity in steel plants. Investment is currently highest in Brazil, where two of the largest steelmakers (both state- controlled) are partially foreign-owned. In the area of steel distribution, the Brazilian firm Siderco has joined with Germany's Metallgesellschaft to sell Brazilian and other Latin American steel products on the world market.[44] Metallgesellschaft is reportedly interested in increasing its presence in the Brazilian market, and Siderco foresees a greater role for Brazilian exports given the current depressed state of the Brazilian economy. The most prominent foreign investment in Mexico focuses on the production of high-value stainless steel. In 1990, Thyssen Edelstahl (Germany) and Acerinox (Spain) each acquired a 33-percent share of Mexinox, Mexico's sole stainless flat-rolled producer. According to a Thyssen spokesman, this action was intended to "provide a good partner for overseas sales,"[45] suggesting that the acquisition should position the European firms for better access to both the North American market (which currently receives about 60 percent of Mexinox production) and to Latin American markets, where demand for stainless steel is expected to increase in response to new, more stringent environmental regulations.[46]

[40] Paul C. Ehrlich, "Globalizing Ugine goes for Thai mill," *American Metal Market*, Nov. 7, 1990, p. 2.
[41] U.S. Department of State Telegram, 1990, Calcutta, message reference No. 11652.
[42] Ibid.
[43] Ibid.
[44] "Siderco teams up with Metallgesellschaft," *Metal Bulletin*, May 3, 1990, p. 28.
[45] "Thyssen, Acerinox take control of Mexinox," *Metal Bulletin*, Apr. 30, 1990, p. 19.
[46] Mexican government and industry officials, interviewed by USITC staff, July 1990.

Outlook

Continued globalization will likely result in a world steel market in which national differences between steel industries will be significantly diminished, particularly to the extent that globalization facilitates industry modernization, improved product technology, and market expansion and refinement.

In the United States, continued foreign investment in steel production and distribution facilities is likely, as foreign steel producers attempt to establish or enhance a U.S. market presence and to supply steel to long-standing clients (e.g., Japanese auto producers). Increasing customer demand for improved product quality and service is likely to be an important factor in the establishment of joint ventures between U.S. and foreign steelmakers, as is a continuing need for capital to fund industry modernization. Foreign investment should improve the competitiveness of U.S. steel plants by providing funds and technology for modernization, thereby resulting in more efficient production and improved product quality. This could create new market opportunities for U.S. steelmakers by enabling them to meet increasingly stringent product demands from transplant customers in the automotive and other industries.

Foreign investment activity outside the United States, although often motivated by similar modernization goals, also reflects concerns specific to a particular country or region. It is likely that future globalization in these regions will continue to be motivated by regional factors. In the EC, the formation of global joint ventures is likely to be motivated by global corporate strategy, rationalization of facilities, and product specialization. Within Europe, the most likely acquisitions are reportedly facilities in the relatively fragmented Spanish and Italian steel industries.[47] Although Japan has expressed interest in developing an automotive production network in Europe, it is unlikely that they will soon establish operations as extensive as their transplants in the United States, since European carmakers are reportedly generally opposed to Japan's presence in the EC market and are lobbying to restrict Japanese investment in the auto industry there. However, any increase in the Japanese presence in the EC steel industry is likely to take the form of investments in finishing facilities that cold-roll and coat sheet and strip for the auto industry.[48]

Although political instability in Central and Eastern Europe could pose unacceptable economic risks to foreign investors, such investment could lead to improved access to previously restricted steel markets. In the Soviet Union, opportunities for foreign equity investment exist with respect to the modernization of plant and equipment, the training of managers for the eventual transition to a less regulated economy, and the

[47] Leadbeater, "Forging a bridge to Europe."
[48] EC steelmakers, interviewed by USITC staff, April 1991.

Table 3-2
Foreign equity investment in selected steelmaking facilities, by region[1]

Region/ country/ company	Foreign partner/ owner	Foreign country	Share of foreign ownership	Start-up date	Apparent reason for investment	Total investment	Existing (E) or new (n)	Activity	Project or asset
			Percent			$ million			
North America:									
Canada:									
Stelco	Mitsubishi Corp. (Mitsubishi Canada)	Japan	40	1990	A,C	(2)	N	C	72"-wide galvanizing facility at Hilton Works in Hamilton, ON
United States:									
Al Tech Spec. Steel	Sammi Steel	South Korea	100	1989	C	350	E	S	All facilities in U.S. and Canada
Alloy & Stainless	Usinor-Sacilor (Ugine)	France	100	1990	C	(2)	E	D	Stainless bar and wire processor /distributor
Arkansas Steel	Sumitomo	Japan	25	1989	C	(2)	E	C	All facilities
Armco	Kawasaki	Japan	[3]40	1989	A,B,C	700	E	C	Eastern Steel Division
Armco	C. Itoh	Japan	50	1987	B,C	(2)	(2)	D	Steel processing facility
Armco	Sumitomo (America) (Vicksmetal Corp.)	Japan	50	1990/91	C	(2)	N	D	Steel slitting facility
Armco Advanced Mats.	Acerinox	Spain	50	1992	A,C	222	N	S	48"- and 60"-wide stainless steel sheet facility, North American Stainless
Armco Advanced Mats.	Avesta	Sweden	100	1990	C	(2)	E	S	Stainless pipe and tube facility in Wildwood, FL
Atlantic Steel	Ivaco	Canada	100	1979	C	(2)	E	C	All facilities
Auburn Steel	Ataka/Kyoei/ Sumitomo	Japan	100	1977	C	(2)	E	C	Steelmaking facility in Auburn, NY
Avesta Inc.	Avesta AB	Sweden	100	1984	C	(2)	E	S	Stainless plate facility in New Castle, IN
Baker Hughes	Sumitomo	Japan	50	1988	C	(2)	E	S	Pipe products
Bethlehem Steel	Usinor-Sacilor (Chavanne-Ketin sub.)	France	50	1989	A,C	(2)	E	C	BethForge facility
Bethlehem Steel[4]	British Steel	United Kingdom	(2)	1991	A,C	(2)	E	C	Structural steel facility (8- to 40-inches in size)
Birmingham Steel	Danielli	Italy	15	1991	(2)	200	E	C	Buffalo Steel facility, Houston, TX

Note.—See footnotes at the end of the table.

Apparent reasons for investment are coded as follows:
- A = Access to production/product technology
- B = Access to capital
- C = Access to new geographic markets/market development
- D = Improvement in customer service
- E = Other, including environmental, trade laws/trade barriers, infrastructure, EC '92

Activity is coded as follows:
- C = carbon steel
- S = specialty steel
- D = service center/distributor
- O = other

Table 3-2 (Continued)
Foreign equity investment in selected steelmaking facilities, by region[1]

Region/ country/ company	Foreign partner/ owner	Foreign country	Share of foreign ownership	Start-up date	Apparent reason for investment	Total investment	Existing (E) or new (n)	Activity	Project or asset
			Percent			*$ million*			
North America:-Cont'd									
United States:-Cont'd									
Calif. Steel Inds.	Kawasaki/CVRD	Japan/Brazil	100	1984	B,C	275 (E)	E	C	Flat rolling plant in Fontana, CA
Connecticut Steel	Korf	W. Germany	100	1985	(2)	(2)	E	C	All facilities
Connecticut Steel	Von Moos Holding AG	Switzerland	(5)	1991	C	(2)	E	C	All facilities
Copperweld	Imetal	France	100	1990	(2)	(2)	E	S	Specialty tubing facility
CSC Industries-Copperweld	Daido Steel/Imetal SA	Japan/France	38/23	1989	C	(2)	E	C	Bar mill in Warren, OH
Edgecomb Metals	Usinor-Sacilor (Sollac)	France	100	1990	C,E	(2)	E	D	Steel service center
Georgetown Steel Co.	Usinor-Sacilor (Unimetal Div.)	France	50	1990	A,B,C	(2)	E	C	Minimill making primarily wire rods
Hawaiian Western El.	Western Canada Steel	Canada	51	1959	(2)	(2)	E	C	Steelmaking facility in Hawaii
Inland Steel	Nippon Steel	Japan	13	1989	B,C	(2)	E	C	Purchase of equity share
Inland Steel	Nippon Steel	Japan	40	1989	A,B,C	400	N	C	I/N Tek cold rolling mill in New Carlisle, IN
Inland Steel	Nippon Steel	Japan	50	1991	A,B,C	200	N	C	I/N Kote galvanizing line in New Carlisle, IN
J&L Specialty	Usinor-Sacilor	France	100	1990	B,C	(2)	E	S	All facilities
Kasle	Tomen (Toyo Menka Kaisha, Ltd.)	Japan	100	1990	C	(2)	(2)	D	Steel service centers specializing in electromagnetic sheet for the auto industry, Coil Center Corp. and Techno Steel Corp.
Klockner Namasco	Klockner	West Germany	(2)	1991	C	(2)	N	D	Steel service center
Laclede	Ivaco	Canada	51	1983	C	(2)	E	C	All facilities
Lakeside Metal Inc.	Wolff Steel Ltd.	United Kingdom	(2)	1990	E	(2)	E	D	Steel service center (tinplate decoiler and sheet slitter)
LTV Steel, Steel Technologies Inc.	Mitsui	Japan	33	1991	D	40	N	D	Two steel processing (slitting and cutting-to-length) facilities
LTV Steel	Sumitomo Metal	Japan	50	1987	A,B,C	100	N	C	Electro-galvanizing line in Cleveland, OH (LSE I)

Note.—See footnotes at the end of the table.

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Table 3-2 (Continued)
Foreign equity investment in selected steelmaking facilities, by region[1]

Region/ country/ company	Foreign partner/ owner	Foreign country	Share of foreign ownership	Start-up date	Apparent reason for investment	Total investment	Existing (E) or new (n)	Activity	Project or asset
			Percent			$ million			
North America:-Cont'd									
United States:-Cont'd									
LTV Steel	Sumitomo Metal	Japan	50	1991	A,B,C	205	N	C	360,000 tpy electro-galvanizing line in Columbus, OH (LSE II)
Marubeni Steel Processing Co.	Marubeni Corp.	Japan	100	1990	E	(2)	N	D	Steel service center
Midrex Corp.	Kobe Steel	Japan	100	(2)	E	(2)	E		Direct reduced iron (DRI) facility
Mon River Steel Corp[4]	(2)	China	(2)	(2)	B,C	300	E	C	Conversion of former USX Mon Valley Works into 2.5 million tpy continuous slab casting facility
National Steel	Dofasco, NKK	Canada, Japan	50,40	1993	C,E	(2)	N	C	400,000 tpy hot-dip galvanizing facility,
National Steel	Marubeni	Japan	50	1986	(2)	(2)	(2)	D	Coil processing facility, ProCoil
National Steel	NKK	Japan	[6]50	1984	A,B,C	320	E	C	All facilities
National Steel Service Center	Sumitomo Corp.	Japan	100	1990	C,F	(2)	(2)	D	Steel blanking and leveling facility, Ohio Metal Processing
New Jersey Steel	Von Roll	Switzerland	100	1983	(2)	(2)	E	C	Steelmaking facility in Sayreville, NJ
North American Steel	Finsteel	Finland	100	1991	C	(2)	N	D	Coil processing facility
Nucor Corp.	Yamato Kogyo	Japan	49	1989	A,B,C	175	N	C	Structural steel facility, Nucor-Yamato, in Blytheville, AK
Ocean State Steel	Von Moos Holding AG	Switzerland	(5)	1991	C	(2)	E	C	All facilities
Phoenix Steel	CITI-Steel	Peoples Repub. of China	100	1989	B,C	14	E	C	Plate mill in Claymount, DE
PMX Inc.	Poongsan Metals	South Korea	100	1992	C	(2)	N	S	180,000 tpy stainless flatrolling facility in Cedar Rapids, IO
Quantech Steel Corp.	SSAB Swedish Steel Corp	Sweden	100	1991	C,D	(2)	E	D	Plate distribution facilities
Raritan River	Co-Steel	Canada	100	1980	C	(2)	E	C	Steelmaking facility in Perth Amboy, NJ
Slater Steel (Ft. Wayne Specialty)	Slater Industries	Canada	100	1980	C	(2)	E	S	Specialty bar mill

Note.—See footnotes at the end of the table.

Apparent reasons for investment are coded as follows:
A = Access to production/product technology
B = Access to capital
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Table 3-2 (Continued)
Foreign equity investment in selected steelmaking facilities, by region[1]

Region/ country/ company	Foreign partner/ owner	Foreign country	Share of foreign ownership	Start-up date	Apparent reason for investment	Total investment	Existing (E) or new (n)	Activity	Project or asset
			Percent			*$ million*			
North America:-Cont'd									
United States:-Cont'd									
Southwest Steel Supply	Hanwa American	Japan	100	1990	C	(2)	E	D	125,000 tpy slitting and cutting facility in St. Louis, MO
Steel Tech	Mitsui	Japan	50	1987	C,E	(2)	(2)	D	Steel service center, Mi-Tech
T.S. Alloys	British Steel	United Kingdom	(2)	1990	C	(2)	E	D	Stainless and other alloy steel processing/ distribution facility in Houston, TX
Tamco	Tokyo Steel/Mitsui	Japan	50	1977	B,C	(2)	E	C	Facility in Etiwanda, CA
Techalloy	Usinor-Sacilor (Imphy Alloys)	France	100	1990	C	(2)	E	D	Stainless rod and wire processor
Tuscaloosa	British Steel	United Kingdom	710	1984	C,E	(2)	E	C	Plate rolling facility
USX	Kobe	Japan	50	1992	A,B,C	200	N	C	Hot-dipped galvanizing facility, Aztec Coating Co.
USX	Posco	South Korea	50	1986	A,B,C	400	E	C	Cold rolling facility, USS-Posco Inds., in Pittsburg, CA
Wheeling-Pittsburgh	Nisshin Steel	Japan	67	1986	A,B,C	70	E	C	Coating line in Follansbee, WV
Wheeling-Pittsburgh	Nisshin Steel	Japan	80	1991	A,B,C	(2)	E	C	Coating line in Follansbee, WV
Whittar Steel Strip	Samuel, Son & Co., Ltd.	Canada	(2)	1991	C	(2)	E	D	Steel service center
Whittaker Metals	Rio Algom	Canada	100	1989	C	(2)	E	D	Four steel service centers
Worthington Inds.	Thyssen Stahl	Germany	50	1993	C	(2)	N	D	Processing facility for laser-welded blanks
Western Europe:									
Germany:									
Hoesch	Usinor-Sacilor	France	100	1991	C	(2)	E	C	Stamping forge facilities
Klockner Mannstadt	British Steel	United Kingdom	100	1990	C	(2)	E	C	Steelmaking facility
Klockner Werke	C. Itoh	Japan	5.1	1990	(2)		E	C	Acquisition of steel and engineering operations
Klockner Werke	C. Itoh	Japan	25	(2)	A,C,E	(2)	N	C	Hot-dip galvanized sheet plant
Saarstahl Volklingen	Usinor-Sacilor	France	70	1989	C	(2)	E	C	Long products production and distribution operations
Thyssen	Hoogovens	Netherlands	25	1992	E	(2)	N	C	400,000 tpy galvanizing line in Duisburg

Note.—See footnotes at the end of the table.

Apparent reasons for investment are coded as follows:
- A = Access to production/product technology
- B = Access to capital
- C = Access to new geographic markets/market development
- D = Improvement in customer service
- E = Other, including environmental, trade laws/trade barriers, infrastructure, EC '92

Activity is coded as follows:
- C = carbon steel
- S = specialty steel
- D = service center/distributor
- O = other

Table 3-2 (Continued)
Foreign equity investment in selected steelmaking facilities, by region[1]

Region/ country/ company	Foreign partner/ owner	Foreign country	Share of foreign ownership	Start-up date	Apparent reason for investment	Total investment	Existing (E) or new (n)	Activity	Project or asset
			Percent			$ million			
Western Europe:-Cont'd									
Italy:	Usinor-Sacilor (Ugine Aciers)	France	(2)	1989-90	C	(2)	E	S	Acquisition of 2 flat-rolled stainless steel mills
Norway (Norsk Blikkvalseverk)	Hoogovens	Netherlands	40	1990	A,C	(2)	E	D	Acquisition of steel sheet processor
Spain:									
Aristrain	British Steel	United Kingdom	45	1990	C	(2)	E	C	Structural steel operations
Ensidesa (Sidmed subsid.)	Usinor-Sacilor	France	32.5	1991	C	(2)	E	C	All Sidmed facilities
Sweden:									
Gavle Ahlsell Ind.	Rautaruukki	Finland	100	1991	C	(2)	E	C	Acquisition of coil coating facility
Uddeholm	Boehler	Austria	(2)	1991	C	(2)	E	S	Merger of production and distribution operations
Turkey (Borcelik Corp.)	Ilva/Usinor-Sacilor	Italy/France	49	1993	C,E	90	N	C	300,000 tpy cold rolling facility
United Kingdom:									
Aberneath Inds.	Sammi Steel Co.	Korea	23.5	1991	A,C	(2)	E	S	Stainless steel cladding plant
Albion Pressed Metal Ltd.	Thyssen	Germany	100	1990	C	(2)	E	C	Flat-rolled automotive steel fabricator
ASD	Usinor Sacilor	France	20	1990	C	(2)	E	D	Second-largest steel distributor in the United Kingdom
Bishopsgate	Altos Hornos de Vizcaya	Spain	50	1990	C	(2)	E	D	Steel trading group
Gwent Steel Ltd.	Hoesch	Germany	80	1990	C	(2)	E	C	Flat-rolled automotive sheet fabricator
Wm. King Ltd.	Mitsui & Co.	Japan	50	1990	C	(2)	N	D	Flat-rolled steel slitting/ processing facility
Eastern Europe:									
East Germany:									
Eisenhuttenkombinat	Thyssen	West Germany	(2)	1990	C	(2)	E	C	Sections facility
Eisenhuttenkombinat	Hoesch	West Germany	(2)	1990	C	(2)	E	C	Strip facility
Eisenhuttenkombinat	Krupp	West Germany	(2)	1990	C	(2)	E	C	Slab facility
Eisenhuttenkombinat	Peine-Salzgitter	West Germany	(2)	1990	C	(2)	E	C	Flat-rolled products facility
Hennigsdorf	Klockner	West Germany	(2)	1990	C	(2)	(2)	S	
Ilsenburg	Peine-Salzgitter	West Germany	(2)	1990	C	(2)	(2)	C	Slab facility
Walzwerk Burg	Thyssen Edelstahl	West Germany	(2)	1990	C	(2)	(2)	S	Stainless strip facility

Note.—See footnotes at the end of the table.

Apparent reasons for investment are coded as follows:
- A = Access to production/product technology
- B = Access to capital
- C = Access to new geographic markets/market development
- D = Improvement in customer service
- E = Other, including environmental, trade laws/trade barriers, infrastructure, EC '92

Activity is coded as follows:
- C = carbon steel
- S = specialty steel
- D = service center/distributor
- O = other

Table 3-2 (Continued)
Foreign equity investment in selected steelmaking facilities, by region[1]

Region/ country/ company	Foreign partner/ owner	Foreign country	Share of foreign ownership	Start-up date	Apparent reason for investment	Total investment	Existing (E) or new (n)	Activity	Project or asset
			Percent			*$ million*			
Eastern Europe–Cont'd									
Hungary:									
Salgotarjan Iron & Steel Works	Ilva	Italy	51	1991	C	(2)	E	S,D	Cold-rolling mill and service center for flat-rolled stainless products
Asia:									
China:									
TISCO and CITIC	Krupp Stahl	Germany	30	(2)	A,C	400	N	C	415,000 tpy high-quality alloy steel mill
(2)	Dongbu Steel	South Korea	(2)	1992	A,C	(2)	N	C	100,000 tpy galvanizing facility in Guangdon province
India (Tata Iron & Steel)	Timken Co.	United States	50	1991	A,C	(2)	N	S	Tapered roller bearing facility
Indonesia (PT Steel Centre)	Mitsubishi Corp.	Japan	(2)	1991	A,B,C	(2)	E	D	150,000 tpy steel service center capacity expansion
Malaysia:									
Anshin Steel Svc Ctr	Marubeni	Japan	75	(2)	C	(2)	(2)	D	Steel service center
Bright Steel Svc Ctr	Mitsui/Tokyo Boeki	Japan	30	1989	C	(2)	E	D	Steel service center, sheet processing
(2)	China Steel	Taiwan	40	1995	A,B,C	(2)	N	C	2.5 million metric tpy integrated steel mill
Philippines:									
Mayer Marubeni Steel	Marubeni	Japan	40	1991	E	(2)	N	D	Two steel service centers
(2)	Mitsubishi	Japan	40	1989	C	(2)	(2)	D	8,000 tpm steel service center
Taiwan (Tung Mung Steel)	Krupp Stahl	Germany	(2)	1993	A,C	(2)	N	S	150,000 metric tpy stain-less steel cold rolling mill
Thailand:									
Bangkok Coil Center	Nippon (Nittetsu Shoji)	Japan	11	1989	C	(2)	E	D	Cold rolled and coated sheet service center
Bangkok Steel Ind.	NISM	Singapore	(2)	1992	(2)	(2)	N	C	360,000 tpy rebar/wire rod mill
Sahaviriya	NKK/Marubeni	Japan	30	1994	C	(2)	N	C	240,000 tpy electro-galvanizing facility
Siam Steel	Nippon Stainless Steel	Japan	49	(2)	C	(2)	N	S	72,000 tpy flat-roll facility in Rayong province

Note.—See footnotes at the end of the table.

Apparent reasons for investment are coded as follows:
- A = Access to production/product technology
- B = Access to capital
- C = Access to new geographic markets/market development
- D = Improvement in customer service
- E = Other, including environmental, trade laws/trade barriers, infrastructure, EC '92

Activity is coded as follows:
- C = carbon steel
- S = specialty steel
- D = service center/distributor
- O = other

Table 3-2 (Continued)
Foreign equity investment in selected steelmaking facilities, by region[1]

Region/ country/ company	*Foreign partner/ owner*	*Foreign country*	*Share of foreign ownership*	*Start-up date*	*Apparent reason for investment*	*Total investment*	*Existing (E) or new (n)*	*Activity*	*Project or asset*
			Percent			*$ million*			
Asia:–Cont'd									
Thailand:Cont'd:									
Thai Steel Pipe Co.	Sumitomo, Nomura Trdg.,Siam Steel Pipe Group	Japan	100	(2)	C	(2)	(2)	C	Welded pipe and tube facility
Thainox Steel Co.	Usinor-Sacilor (Ugine)	France	51	(2)	C	(2)	N	S	Stainless steel sheet facility
(2)	C. Itoh	Japan	51	1989	C,E	(2)	E	D	Acquisition of a 60,000 metric tpy steel processing plant
(2)	Ilva	Italy	(2)	(2)	C	(2)	N	S	50,000 tpy production facility in Prachuab province
Latin America:									
Brazil:									
Companhia Siderurgica de Tubarao	Finsider/Kawasaki	Italy/Japan	24.5/24.5	(2)	C	(2)	E	C	Slab facility
Siderco	Metallgesellschaft	West Germany	(2)	1990	C	(2)	E	D	Steel mill products
Usiminas	Nippon	Japan	12	1990/91	C	(2)	E	C	4.0 million tpy flat rolled products facility
Mexico:									
Mexinox	Acerinox/ Thyssen Edelstahl	Spain/West Germany	33/33	1990	C	(2)	E	S	100,000 tpy stainless cold rolling facility
Venezuela:									
Minerales Ordaz CA	(2)	Japan	(2)	(2)	E	(2)	E	O	DRI facility

[1] Includes equity investment in steel processing and finishing facilities and in distribution chains and service centers.
[2] Not available.
[3] Increased ownership to 50 percent in 1990.
[4] Under consideration.
[5] Majority owner.
[6] Increased ownership to 70 percent in 1990.
[7] Increased ownership to 100 percent in 1990.

Apparent reasons for investment are coded as follows:
- A = Access to production/product technology
- B = Access to capital
- C = Access to new geographic markets/market development
- D = Improvement in customer service
- E = Other, including environmental, trade laws/trade barriers, infrastructure, EC '92

Activity is coded as follows:
- C = carbon steel
- S = specialty steel
- D = service center/distributor
- O = other

Source: Various issues of American Metal Market, Metal Bulletin, and Steels Alert; and U.S. International Trade Commission, *Annual Survey Concerning Competitive Conditions in the Steel Industry and Industry Efforts to Adjust and Modernize* , Investigation No. 332–209, USITC publication 2226, October 1989.

financing of the foreign exchange costs of new equipment. In Eastern Europe, the withdrawal of government assistance from steel plants is likely to encourage joint ventures with Western partners in order to secure financing for needed modernization, should Eastern European countries be willing to endure the associated layoffs of steel employees.

Foreign investment in the Asian steel industry is likely to continue. Japanese steelmakers are likely to continue to establish joint ventures abroad, although such investments could well include more in the EC, especially if Japanese automakers are successful in establishing facilities there. Future Korean joint ventures could likely focus on Korea's increasing technological capabilities and its ability to market this expertise. According to the trade press, Posco and other South Korean steel companies have reached such a level of technological sophistication that Korean steel technology (perhaps in combination with South Korean equipment) could be competitively exported. In Taiwan, globalization efforts are likely to continue given CSC's goals for internationalization.

In Latin America, the movement toward privatization of the steel industry in a number of countries is likely to provide more opportunities for foreign investment, as firms seek new sources of technology and capital.[49] Future foreign joint ventures in Brazil are likely in order to provide alternative sources of funds for modernization; currently, the Brazilian government is burdened with $17 billion in debt retained by the steel holding company Siderbras. However, the expansion of joint ventures could be constrained by the Brazilian government's plan for privatization which currently limits foreign ownership to 40 percent of mills.[50] In addition, purchasing requirements stipulating that the transaction contain a certain percentage of Brazilian Deposit Facility Agreements (DFAs), certificates which are purchased from the Brazilian government and used in a debt-for-equity type of swap, may limit most new foreign investment to debt-for-equity swaps.[51] More opportunities for foreign investment in the Mexican steel industry are likely with the privatization of two parastatal firms. There is no restriction on the share of foreign-held ownership in the Mexican steel industry.[52]

Government Policy

Government involvement in the world's steel industries has been significant over the past twenty years, and has taken the form of ownership, financial assistance, regulation, and trade measures. Such involvement has altered the competitive environment, significantly affecting world steel production and trade patterns, as well as the flow of investment. The effects of these policies on the industry's conduct, performance, and structure are depicted in figure 3-1.

This chapter identifies and assesses: (1) the degree of government involvement in the industry during the past 20 years, and how such involvement has changed over time; (2) the effect of this involvement on the competitive environment; and (3) the competitive implications of efforts to reduce government involvement. This assessment is specific to the steel industry, and although it is global in scope, special attention is paid to the U.S. industry.

Discussion of Findings

During 1970-91, steel industries commanded considerable attention from national governments. Intervention in the form of state ownership, financial assistance, export promotion, and import barriers was widespread. From 1970 to 1975, governments supported industry expansion through ownership (particularly in developing countries), financial assistance, and trade policies that discouraged imports (through relatively high tariffs and nontariff restrictions) while promoting exports. Between 1976 and 1985, continued support to expand capacity in certain countries was joined by substantial governmental intervention to support companies experiencing financial difficulties.

Since 1985 many governments have begun to reduce involvement in the industry. Some of this withdrawal, including reduced financial assistance, reflects the completion of restructuring efforts. Other actions, namely efforts to diminish or fully relinquish government ownership, appear to have longer term significance. Future involvement may also be reduced if negotiation of a multilateral steel agreement (MSA) under the GATT is successful. Successful negotiation of an MSA may reduce or eliminate tariff and nontariff barriers affecting steel, and may limit government assistance.

Government involvement in the industry affected the competitive environment in various ways. During the past two decades, financial assistance was instrumental in constructing new facilities, increasing access to investment capital, and preserving certain firms. The creation and maintenance of capacity appears to have contributed significantly to imbalances between steel capacity and consumption. Excess capacity tended to reduce prices and profitability. Lower profitability, in turn, likely diminished the incentive and the ability of many producers to invest in the industry. In addition to affecting overall conditions in the industry, government efforts to enhance the industry's financial performance through trade and related measures affected production and trade patterns, effectively spreading the burden of adjustment among all steel-producing countries.

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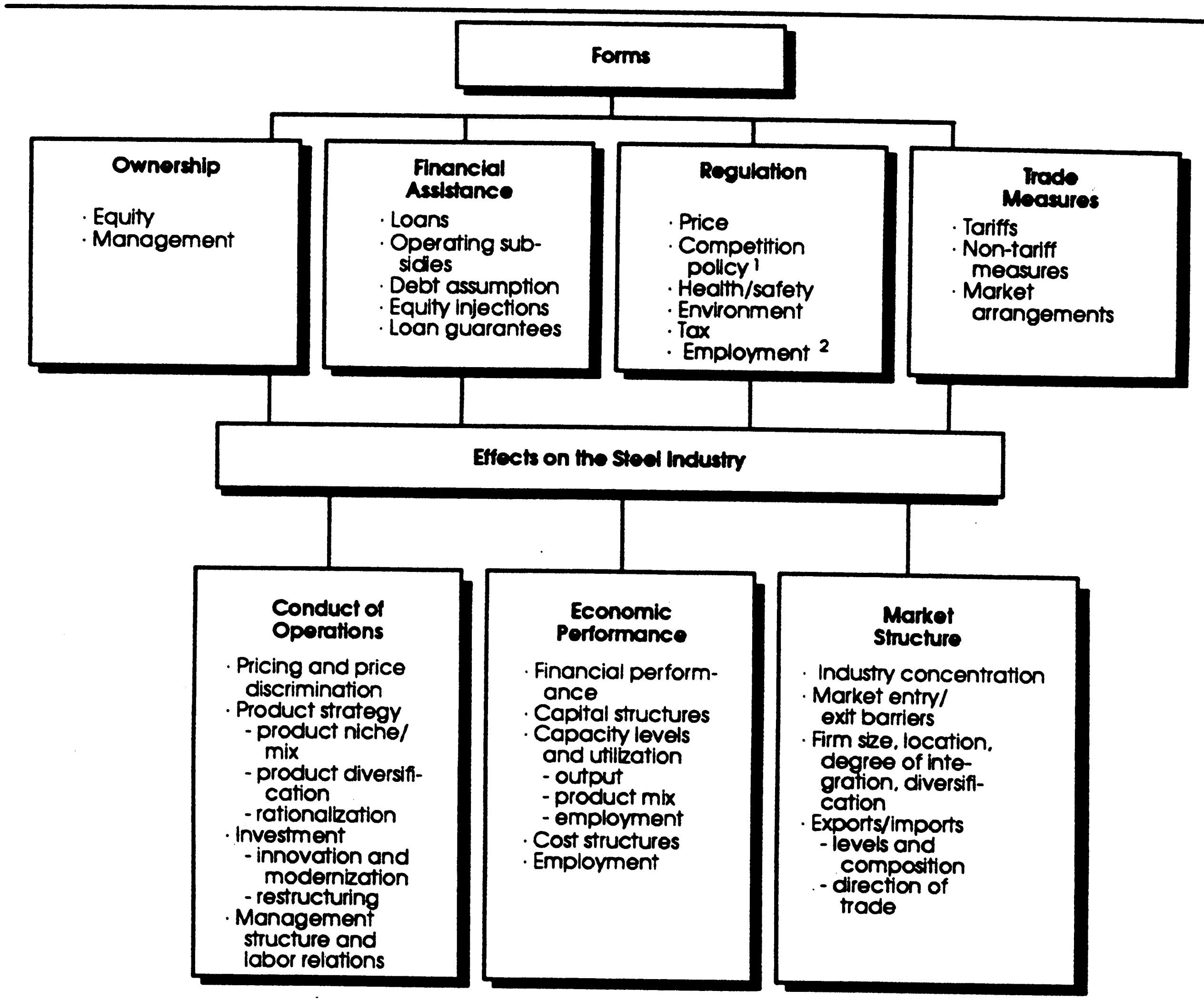
[49] Christopher Plummer, "The New Game in Steel Capital Funding," *American Metal Market*, International Steel Supplement, Oct. 8, 1990, pp. 14A,18A.

[50] Michael Kepp, "Brazil's steel output, exports to fall significantly: IBS," *American Metal Market*, Oct. 5, 1990, pp. 4,10.

[51] *Metal Bulletin*, Nov. 11, 1990.

[52] *Metal Bulletin*, Dec. 6, 1990, p. 14.

Figure 3-1
Forms and effects of government involvement on the steel industry



[1] Refers to fair trade regulations (e.g., antitrust, prices, marketing conduct).
[2] Includes employment and post-employment policies, such as income maintenance, worker retraining, unemployment compensation, and pension benefits.
Source: Adapted from F.M. Scherer and David Ross, *Industrial Market Structure and Economic Performance* (Boston: Houghton Mifflin Co., 1990).

The U.S. industry appears to have been one of those most affected, as it had relatively little financial assistance and relatively low tariffs. Various trade measures, principally in the form of import relief, were the primary means through which the government became involved, although a number of other adjustment measures were also provided.[53]

Recent government interest in opening markets and reducing involvement may result in significant shifts in production and trade patterns, as well as shifts in investment flows. In the trade area, liberalized access to foreign markets would provide new opportunities for exporters who had focused on the U.S. market. The reduction of government involvement may have even greater benefit, however, to the extent that business decisions increasingly are made on the basis of economic viability. Reduced government intervention

[53] Aid to the U.S. steel industry tended to be indirect and was provided through increased depreciation rates, investment in the form of loan guarantees from the Economic Development Administration, and financial assistance to steelworkers, e.g., rent assistance, relocation and retraining, and contributions to State unemployment compensation funds. A.W. Harris, *U.S. Trade Problems in Steel: Japan, West Germany, & Italy* (New York: Praeger

[53]*—Continued*
Publishers, 1983) pp. 86-87, citing the *Administration's Comprehensive Program for the Steel Industry* (the Solomon Report), January 1978.

could result in increased profitability for all producers and an improvement in the relative cost position of the U.S. industry.

Forms of Government Policy

Government Ownership

Government ownership can affect all aspects of a business, including long range goals, investment, production, trade, and prices. In the 1960s and 1970s it also appears to have lowered the perceived risk associated with investing in, or loaning to, industries.[54]

Government ownership of steelmaking assets, already formidable at the outset of the 1970s, grew significantly during the 1970s and 1980s, and has declined since 1986 (see table 3-3). Of the major steel-producing countries, only the governments of the United States, Japan, and Australia held no ownership in steel companies during the two decades; in most other countries, the level of ownership was relatively high.

Developed Countries

The share of steel output accounted for by government-owned or government-controlled companies in Western Europe increased from about 32 percent to nearly 55 percent between 1968 and 1986, principally as governments assumed ownership of failing companies.[55] As in many developing countries (see discussion below), state-owned steel companies often accounted for a majority of a countries' production. In addition, development of the steel industry or individual steelmaking facilities also facilitated the achievement of regional industrialization goals. Industrialized countries that nationalized companies include the United Kingdom, Belgium, and France.

Developing Countries

Government ownership in developing countries tended to occur at earlier stages of the steel industry's formation than in developed countries. Private investment in the steel industry was often discouraged by high risks and large capital requirements.[56] State-owned companies, therefore, tended to dominate raw steel production, accounting for most of the capacity expansion within these countries.[57] Government ownership of steelmaking facilities was widespread throughout Latin America (Mexico, Brazil, Venezuela, and Argentina) and the Far East (South Korea, Taiwan, India, Indonesia, Malaysia, and Thailand).

Privatization

In a number of countries, ownership has been relinquished or reduced in recent years, and similar action is presently being contemplated in others. Approximately 31 percent of the Western World's steelmaking capacity was state-owned in 1987-88; by 1990, the percentage had fallen to about 25 percent. Full divestiture was undertaken, for example, in the United Kingdom (British Steel), whereas partial divestiture has occurred in West Germany, Belgium, South Africa, South Korea, and Taiwan.[58] Privatization of certain facilities is reportedly being contemplated by the governments of Italy, Mexico, Brazil, Malaysia, Thailand, Indonesia, and the Philippines. Several countries in Central and Eastern Europe are contemplating privatization as well.[59]

The objectives of privatization are typically to promote efficiency and to reduce government obligations. As with any investment, the decision to invest principally depends on anticipated profitability, which is likely estimated on the basis of mills' technological condition, location, resource availability, and in some cases, the extent of government assistance or incentives.

Financial Assistance

Financial assistance has been provided to the steel industry in many different forms during the past 20 years.[60] Assistance of one type or another has been extended to the steel industry in nearly every country and to both government- and privately-owned steel companies. The assistance took the form of loans, grants, and preferential access to capital markets. Financial assistance allowed the companies to increase capacity, maintain operating rates, and undertake restructuring and modernization programs. It appears that the level of assistance has fallen significantly since 1985.

Importance of Financial Assistance

Financial assistance can reduce operating costs and facilitate the maintenance, modernization, and expansion of capacity. Moreover, government assistance has enabled some companies to undertake significant investment programs during the 1980s despite years of financial losses. Access to low-cost investment capital and operating subsidies provided

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[54] [* * *].

[55] Thomas R. Howell, William A. Noellert, Jesse G. Kreier, and Alan Wm. Wolff, *Steel and the State: Government Intervention and Steel's Structural Crisis* (Boulder, CO: Westview Press, 1988), ch. 3.

[56] For example, when a World Bank study recommended against assistance to establish an integrated steel mill in Korea, the government then funded the development program itself. (Ibid., ch. 5).

[57] Ibid.

[58] Officials at the International Iron and Steel Institute, telephone interview by USITC staff, April 1991.

[59] *American Metal Market*, May 23, 1990, p. 3.

[60] Financial assistance has taken the form of debt relief, financial guarantees, equity injections, operating funds, wage funds, investment funds, preferential tax incentives, special tax exemptions for government firms, and preferential utility rates.

Table 3-3
Raw steelmaking capacity by class of ownership in 1968 and 1986, privatization efforts since 1986, and stated intentions to privatize since 1986, by country

Region/country	*Percentage of state ownership*[1] *1968*	*1986*	*Privatization efforts since 1986*[2]
Western Europe			
Austria	88.6	91.9	
Belgium	0.0	52.5	x
Finland	70.0	69.1	x
France	0.0	88.3	x
West Germany	5.6	12.4	x
Italy	58.8	86.9	x
Netherlands	0.0	15.0	
Norway	75.0	100.0	
Portugal	0.0	100.0	x
Spain	53.1	56.6	x
Sweden	9.8	55.4	x
Turkey	100.0	59.9	
United Kingdom	88.2	83.9	x
Yugoslavia	100.0	100.0	
Centrally-Planned Economies			
USSR	100.0	100.0	
Central & Eastern Europe	100.0	100.0	x
North America			
United States	0.0	0.0	([3])
Canada	7.8	9.5	
Pacific Rim			
Japan	0.0	0.0	([3])
India	72.9	65.2	
Malaysia	0.0	31.5	
South Korea	0.0	65.1	x
Taiwan	60.0	57.2	x
Australia	0.0	0.0	([3])
New Zealand	0.0	83.3	x
South Africa	87.5	81.8	x
Latin America			
Argentina	66.7	53.8	
Brazil	66.7	72.8	x
Mexico	54.5	59.7	x
Venezuela	55.6	87.9	
World	41.8	53.1	([3])

[1] Percentage of government equity ownership of raw steelmaking capacity.
[2] Include actual sales of equity to nongovernmental institutions or publicly announced intentions to privatize.
[3] Not applicable.
Source: Compiled from statistics of the International Iron and Steel Institute; Howell, *Steel and the State*; and industry publications.

companies with a competitive advantage over those without similar government support.[61]

The significance of steel-specific government financial assistance is illustrated, in part, by findings of subsidies by the U.S. Department of Commerce in investigations under the U.S. countervailing duty (CVD) laws in cases reviewed during the 1980s.[62]

[61] William T. Hogan, S.J., *World Steel in the 1980s* (Lexington, MA: D.C. Heath and Co., 1983), pp. 49-50.

[62] Under the U.S. countervailing duty laws (set forth in sections 303 and 701 et seq. of the Tariff Act of 1930 (19 USC 1303, 1671 et seq.), a countervailing duty is imposed in an amount equal to the amount of the subsidy when Commerce has found a subsidy and (generally) when the U.S. International Trade Commission has determined that a domestic industry is materially injured or threatened with material injury, or the establishment of an industry is materially retarded, by reason of such subsidy.

Table 3-4 indicates the range of preliminary or final subsidy determinations for products on which investigations were conducted, by country:[63]

Financial Assistance in the EC

Government assistance to steel companies in the EC facilitated capacity expansion while the closure of other facilities was postponed, resulting in excess capacity. Such capacity contributed significantly to declining prices as companies exported surplus production; moreover, it reportedly motivated the extension of financial assistance by other governments.[64] In 1981, the EC Commission estimated excess capacity in the Community at 50 million metric tons;[65] as late as 1989, European industry sources indicated that excess capacity was on the order of 10 to 15 million metric tons.[66]

Estimates of the amount of assistance provided to the national steel companies in Belgium, France, Italy, and the United Kingdom range from $17 to $42 per metric ton of raw steel produced during 1975-79. These amounts approximately doubled during 1979-83.[67] Assistance of this magnitude was reportedly extended because of rapidly deteriorating financial health of certain European firms.[68]

Amounts of assistance provided to the EC steel industry, as recorded by the EC Commission, are shown in table 3-5.

[63] Based on official statistics of the U.S. Department of Commerce. The subsidy calculations shown in the table are amounts of subsidy that are countervailable. There may be, in some instances, additional government assistance that might be considered a subsidy but which is not countervailable (e.g., assistance that is generally available and not industry specific).

[64] Howell, *Steel and the State*, pp. 55-58.

[65] EC Commission, *Comments on the General Objectives Steel 1985*, February 16, 1984.

[66] Staff interviews, Munich, Germany November 1989.

[67] German Iron and Steel Association estimates cited in Verner, Liipfert, Bernhard, McPherson, and Hand, *Government Aid to the Steel Industry of the European Communities* (manuscript, 1984), p. 6.

[68] For an analysis of the financial viability of the steel companies and the amounts of subsidies extended to them see, *Europe* No. 3625, June 10, 1983, quoted in Verner, Liipfert, *Government Aid*, p. 19; and, Yves Meny and Vincent Wright, "State and Steel in Western Europe," in *The Politics of Steel: Western Europe and the Steel Industry in the Crisis Years (1974-1984)*, ed. by Meny and Wright (Berlin: Walter de Gruyter, 1986), p. 4.

Table 3-4
Preliminary and final subsidy determinations on certain steel products

Country	*Range of subsidy calculations*
	percent ad valorem
Argentina	0.09 - 13.80
Austria	1.82 - 2.27
Belgium	0.49 - 13.41
Brazil	12.53 - 36.95
Canada	0.72 - 113.56
France	3.70 - 21.42
West Germany	0.00 - 1.31
Iran	336.14
Israel	11.86
Italy	17.81 - 26.05
Japan	2.00
South Korea	0.16 - 8.73
Mexico	2.03 - 104.58
New Zealand	5.25 - 45.01
Peru	29.98
Philippines	10.20
Saudi Arabia	5.48
South Africa	6.70 - 21.64
Spain	0.00 - 29.94
Sweden	2.18 - 38.25
Thailand	1.10 - 1.79
Trinidad & Tobago	6.74
Turkey	17.80
United Kingdom	1.88 - 20.33
Venezuela	70.98 - 72.26
Yugoslavia	74.50
Zimbabwe	47.33

Source: Compiled from official data of the U.S. Department of Commerce.

Table 3-5
State-granted investment, research and development, closure, operating, and emergency subsidies, by country, 1980-88

(In million dollars)

Country	Investment	R&D[1]	Closure	Operating	Emergency	Total
Belgium	711	0	120	3,104	12	4,211
Denmark	13	0	0	69	0	82
Fed. Rep. of Germany	1,108	201	769	1,921	0	3,999
France	3,006	24	299	5,055	681	9,065
Ireland	0	0	0	261	0	261
Italy	3,949	43	229	[2]13,141	0	17,362
Luxembourg	435	6	15	174	0	630
Netherlands	231	0	0	220	0	451
United Kingdom	1,768	48	1,025	2,737	0	5,578
Spain[3]	1,846	0	346	1,184	0	3,376
Portugal[3]	95	0	358	153	0	606
Total	11,332	322	3,161	28,019	693	45,621

[1] Includes financial assistance granted for environmental research and technology.
[2] Includes amounts involved in the transfer of Finsider to ILVA.
[3] Spain and Portugal were granted transitional periods of 3 years (until yearend, 1988) and 5 years (until yearend, 1990), respectively, during which time steel firms could continue to receive operating aid, and aid for investment, closures, and R&D.

Source: Data for the period 1980-85 are based on the Report from the Commission to the Council on Application of the Rules on Aids to the Steel Industry, COM(86) 235 final, August 6, 1986, as reported in *Steel and the State* (table 3-3); data for the period 1986-88 are based on the EC Commission's *Report on the Application of the Rules on Aids to the Steel Industry, 1986-1988*, SEC(90) 18 final, dated January 24, 1990.

Financial Assistance in Japan

An important aspect of government policy in Japan has been the extension of low-cost and preferential credit to the steel industry through the Bank of Japan.[69] The government of Japan has also provided research and development funds designed to enhance energy efficiency and develop new technologies and overseas sources of raw materials.[70] Furthermore, the steel industry has been the beneficiary of tax benefits including liberal depreciation allowances and a variety of export-promoting tax measures.[71]

Financial Assistance in the United States

Local municipalities, states, and the federal government have assisted the U.S. steel industry in maintaining production and employment. Approximately $322 million in loans to the industry was guaranteed by the Economic Development Administration; local tax concessions reportedly totaled about $114 million.[72] Since the mid-1980s, the federal government has provided about $60 million in research and development funding to the steel industry through several programs,[73] and extended a one-time special taxcredit for capital investment expenditures in 1987, worth about $574 million.[74]

Financial Assistance in LDCs

In many developing countries, the state, rather than private companies, plans investment and expansion, allocates resources, and makes decisions with respect to domestic pricing, product mix, and export strategy. The Korean government, for example, has emphasized low-cost and preferential credit to the steel industry.[75] Aid to the steel industry in Korea totaled about $4 billion during 1975-88,[76] with countervailable subsidies representing between 2 percent and 4 percent of the production cost of sheet and strip.[77] Government repayment guarantees enabled POSCO to raise about one-half of the capital necessary for its

[69] Howell, *Steel and the State*, p. 196.
[70] Ibid., pp. 200-201.
[71] Ibid., p. 198.
[72] *The Canadian Steel Producers Association Report on Government Assistance to the U.S. Steel Industry*, Final Report, October 1989, pp. 6-10; David J. Cantor, "Comments on the CSPA Report," Congressional Research Service Memorandum dated May 24, 1990.

[73] USITC, Steel Industry Annual Report, USITC publication 2316, pp. 32-39.
[74] Dewey, Ballantine, Bushby, Palmer & Wood, "Preliminary Survey of U.S. Steel Producer Subsidies," (manuscript 1990), p. 1.
[75] Howell, *Steel and the State*, p. 294. See also, Brent Bartlett, Jason Evans-Tovey, and Gregory Hume, "Preferential Allocation of Credit to the Korean Steel Industry by the Government of Korea," (manuscript, 1989); World Bank, *Korea: Managing the Industrial Transition, the Conduct of Industrial Policy*, (Washington, D.C., 1987).
[76] Howell, *Steel and the State*, p. 306.
[77] U.S. International Trade Commission, *U.S. Global Competitiveness: Steel Sheet and Strip Industry*, investigation No. 332-231, publication 2050, January 1988, table I-5.

expansion efforts from foreign banks.[78] In addition, the Korean Government encouraged POSCO's suppliers to extend the company credits by guaranteeing repayment,[79] and provided a variety of fiscal, transportation, and resource benefits to the company under the 1970 Steel Industry Promotion Act, including preferential finance for export enterprises.

Similar government efforts were evident in South America. The Government of Venezuela made direct purchases of equity in SIDOR totaling about $1.2 billion between 1976 and 1983 through the Fondo de Inversiones de Venezuela (FIV); FIV converted another $675 million in debt to equity during 1980-83.[80] Siderbras, the Brazilian state holding company, invested an estimated $14.4 billion between 1977 and 1986, in export incentives, direct cash infusions, and a variety of tax and fiscal concessions.[81] The Mexican steel industry, on the other hand, was granted approximately $1.8 billion during 1970-87 by the Federal government, which also assumed over $1 billion in debt during the mid-1980s.[82]

Extra-governmental agencies have also been active. World Bank loans for developing country steel industries totaled 1.327 billion between 1970 and 1987.[83] The World Bank also focused on helping countries like Brazil acquire funds from private and other multilateral agencies. Discussions with Bank staff suggest that future activity will likely include the funding of technical assistance studies regarding steel industry restructuring. A recent loan to Poland, for example, was made for this purpose.[84]

Efforts to Limit or Eliminate Assistance

Government policies regarding assistance shifted during the 1980s. In several cases, subsidies apparently ceased following the completion of modernization and restructuring plans and the assumption of the company debt by the state. In the EC, adoption of a state aids code in 1981 stipulated that limited aid could be extended to further research and development, to implement certain environmental legislation, to facilitate certain plant closures, and to develop certain regions. The state aids code will be in effect through 1991.[85] In 1989, the U.S. government concluded Bilateral Consensus Agreements, largely based on the EC state aids code, with a number of countries that agreed to continue the program of Voluntary Restraint Agreements.

To the extent that privatization continues, it appears that subsidies to the steel industry could decline as governments will no longer have as direct an interest in the business.[86] On the other hand, certain forms of financial assistance may be revived during periods of recession or to further modernization and adjustment.

Regulation

The world's steel industries are subject to numerous types of government regulations. The regulations range from financial disclosure requirements and health and safety regulations, to antitrust laws, price controls, and environmental standards. Such regulations can be numerous; a study conducted by the U.S. Council on Wage and Price Stability in 1976, for example, indicated that the U.S. steel industry was subject to more than 10,000 regulations in the mid-1970s.[87] While the number may have changed since that time, discussions with an industry executive suggest that the current total is probably of the same order of magnitude. Such regulations are significant to the extent that they affect prices, costs, and business strategies (such as mergers, acquisitions or joint ventures).

Regulations affecting trade and environmental standards are discussed in separate sections of the report; following are brief discussions of some other forms that have been used in countries during the past 20 years.

Price Controls

Price regulation has been more extensive in developing countries than in the developed world. For example, the government of India controls both the prices of inputs, such as scrap metal, and domestic prices for most products manufactured by integrated steel plants (including privately-owned companies).[88] Taiwan attempted a two-tiered price system, one price for the domestic market, and a lower price for steel exports.[89] Krakatau, the state-owned steel company in Indonesia, has maintained a three-tiered pricing system designed to enhance the competitiveness of steel-intensive exports.[90]

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[78] Howell, *Steel and the State*, pp. 295-97.
[79] Ibid., p. 294.
[80] U.S. Department of Commerce, Non-Confidential Response of the Government of the Republic of Venezuela, Countervailing Duty Investigation, No. C-307-403, Feb. 25, 1985; see also, financial statements of the steel company, SIDOR.
[81] Howell, *Steel and the State*, p. 263.
[82] Ibid., pp. 310 and 316.
[83] U.S. International Trade Commission, *Sheet and Strip*, p. 4-10. Figures includes $400-million steel sector development loan to Mexico, the only World Bank loan for steel capacity expansion made since 1987. World Bank personnel, interviews with USITC staff, May 1991.
[84] Ibid.
[85] Verner and Liipfert, *Government Aid*, p. 21.
[86] This is reflected in a stronger stand against state ownership in many countries. Sir Leon Brittan, EC Commissioner for Competition, remarks cited in Kellaway, "Brittan on the trail of aid to state companies," *Financial Times*, Nov. 19, 1990, p. 6.
[87] U.S. Council on Wage and Price Stability, *Catalog of Federal Regulations Affecting the Iron and Steel Industry* (Washington, D.C.: December 1976), p. 217.
[88] Jamshed Batliwala, presented at Steel Survival Strategies VI, June 19, 1991; see also, U.S. Department of State Airgram, Oct. 5, 1989, Calcutta, message reference No. Calcutta A-07.
[89] Howell, *Steel and the State*, p. 332.
[90] Ibid., p. 363.

In the United States, federal government efforts to influence prices during periods of inflation ranged from informal efforts to pressure firms not to raise prices to price regulations that were legally enforceable through judicial or administrative proceedings.[91]

Beginning in 1977, the European Community sought to stabilize steel prices by setting price floors and production quotas.[92] Under the Davignon Plan, the EC Commission and Eurofer (the producers association) urged producers to follow voluntary production quotas and developed a system of price floors, some of which were mandatory, for a range of steel mill products. By the end of 1980, the EC Commission made certain production quotas mandatory. Although these market controls were largely relaxed by 1985[93] certain elements of the program remained through 1988.

Antitrust Policies

In the United States, antitrust policies place conditions on acquisitions if they result in reduced competition[94] The 1984 merger of Jones & Laughlin Steel Corp. and Republic Steel Corp., for instance, required the divestiture of both the integrated steel mill at Gadsden, AL, which became Gulf States Steel, and the stainless sheet finishing mill at Massillon, OH[95] In the EC, many companies have entered into producer alliances that resulted in informal market sharing arrangements. For example, the EC Commission authorized the formation of German "Rationalization Groups" in 1971, which reportedly provided an institutional framework for self-regulated competition and price coordination among 31 West German producers.[96]

In Japan, the Ministry of International Trade and Industry (MITI), has reportedly provided production guidance[97] In addition, the leading Japanese integrated producers have for many years reportedly met on a weekly basis in the presence of MITI officials to exchange market data and discuss appropriate production levels and other related issues.[98] Japan's antitrust law was reportedly modified to permit the formation of a domestic cartel, allowing steel producers to agree on output, prices, and investment, as well exports and imports.[99]

In many LDCs, regulation is more widely applied. In India, for example, the government has limited the size of private companies permitted to compete with the state-owned company, SAIL.[100] In Malaysia, the government has required rerollers to purchase billets from the state-owned steel mill, Perwaja, since 1986.[101] Moreover, to protect Perwaja's market share, the government vetoed plans by a partially state-owned company to purchase an electric arc furnace and billet caster.[102] Finally, the government gave Perwaja the sole right to sell direct reduced iron (DRI) on the domestic market.[103] In Indonesia, the government decreed that Krakatau, the state- owned steel mill, was to be the sole licensed importer of a wide range of steel products.[104] In Thailand, the government recently awarded a license for the construction of a flat products finishing facility; no other company will be permitted to construct a similar facility in the country until after the year 2000.[105]

Trade Policy

During the past 20 years, many steel producing countries maintained or adopted policies to protect their industries from foreign competition. Such policies have included tariffs, taxes, quantitative limitations, and foreign exchange restrictions. Import and export policies affected the competitive environment by altering production and trade flows that otherwise would have resulted from interfirm competition.

Tariffs

The tariffs on steel imports were relatively high during 1970, but have generally been reduced as a result of unilateral and multilateral actions. As shown in tables 3-6 and 3-7, tariff levels have generally

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[91] COWPS, *Catalog*, p. 197. Formal price controls were enacted under the Economic Stabilization Act of 1970 and administered from August 15, 1971 until May 30, 1974. There was a 90-day period during which prices were frozen, followed by three periods of progressive relaxation of the price increase guidelines. The Council on Wage and Price Stability was created following the termination of the Economic Stabilization Program. During the Carter Administration, Federal procurement policies and contracts were amended to contain price escalator clauses and reduce the purchase of goods whose prices did not comply with the voluntary anti-inflation guidelines. *(Public Papers of the Presidents*, "Administration of Jimmy Carter," 1977, p. 623 and 1978 pp. 724 and 1919.)

[92] Howell, *Steel and the State*, p. 56.

[93] Ibid., pp. 87-88.

[94] COWPS, *Catalog*, p. 143. The principal factors considered are the concentration of the relevant market and the sizes of the acquiring and acquired firms. Another factor is the financial viability of the acquired firm in the absence of a merger.

[95] Frederick J. Schottman, "Iron and Steel," *Minerals Yearbook 1984*, U.S. Bureau of Mines, p. 511.

[96] Howell, *Steel and the State*, p. 176.

[97] Ibid., p. 202.

[98] Ibid., pp. 203-204.

[99] Ibid., p. 205, citing Japan's Antimonopoly Law, Articles 24-3 and 24-4, and provisions of the Export and Import Trading Law.

[100] Jamshet Batliwala, Steel Survival Strategies VI.

[101] "Steel slips off the growth curve," *Metal Bulletin Monthly*, August 1986, p. 80.

[102] *Metal Bulletin*, May 17, 1990, p. 29.

[103] Ibid.

[104] Howell, *Steel and the State*, p. 353.

[105] "Ministry may scrap ban on steel mills," *Bangkok Post*, Oct. 17, 1990; also, "BoI reaffirms support for Sahaviriya project," *Bangkok Post*, Nov. 13, 1990.

Table 3-6
Certain carbon steel products and stainless cold-rolled sheet: Ad valorem tariff rates applicable in 1970, by country or region[1]

Country and Period	Slabs	Hot-rolled sheet	Cold-rolled sheet	Coated sheet: Tin	Coated sheet: Galvanized	Hot-rolled bars	Structurals	Flat Wire	Pipe and tube	Stainless cold-rolled sheet
United States	7-7.5	7.5	[2]8.6	[2]7.4-8.5	[2]8.8-9	7-9	[2]1.5-7.5	[2]6-8.8	[2]1.1-11.6	[3]10.5
EC	5.6-7	5.6-7.8	7.2-8.2	6.6-8.2	8.8	6.8-7.2	6.8-7.2	8	10.2-11.6	7.4-8.8
Canada	5	Free-10	Free-12.5	12.5	12.5	10	Free-17.5	7.5	5-15	Free-12.5
Japan	8.75	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	12
Korea[4]	10	30-40	30-40	40	40	25	25	35-40	20-50	15-40
Brazil[5]	37	20	20	20	45	37	37	45	37-45	45
Mexico	25	2	2	30	65	10-30	7-80	5-35	7-30	5

[1] For all countries except Mexico, tariffs correspond to rates applicable to GATT-member countries, excluding those countries covered by special arrangements (e.g., GSP). Mexican tariffs correspond to rates applicable to all countries except those with which Mexico had special arrangements.
[2] Converted from specific tariff rate or combined (specific and ad valorem) tariff rate.
[3] Base tariff rate. Additional duties applied depending on content of chromium and other alloys.
[4] Reflects 1973 tariff schedule.
[5] Reflects 1973-74 period.

Sources: Harmonized Tariff Schedule of the United States (United States); Official Journal of the European Communities (EC); International Customs Journal, No. 6, June 1973 (Brazil); McGoldrick's Canadian Customs Tariff (Canada); Customs Tariff Schedules of Japan (Japan); Tariff Schedules of Korea (Korea); and International Customs Journal, No. 27, March 1970, and the U.S. Department of Commerce (Mexico).

Table 3-7
Certain carbon steel products and stainless cold-rolled sheet: Ad valorem tariff rates applicable in 1990, by country or region[1]

Country and Period	Slabs	Hot-rolled sheet	Cold-rolled sheet	Coated sheet: Tin	Coated sheet: Galvanized	Hot-rolled bars	Structurals	Flat Wire	Pipe and tube	Stainless cold-rolled sheet
United States[2]	4.2	4.9-5.1	5.1	3.5	6.5	1.9-4.7	0.9-4.9	3.2-5.2	0.5-8	10.1
EC	3.2-3.8	3.8-4.4	4.4-4.9	4.9	4.9-5.3	4.4-4.9	4.4-4.9	5.3	10	6
Canada[2]	4	6.8	6.8-8	7.7-8	8	6.8	6.8	5.7-6.8	6.8-10.2	12.5
Japan[2]	4.3-5.8	4.9-5.8	4.9-5.8	4.9	4.9-5.8	4.9-5.8	4.9	4.9-5.8	4.9	5.8
Korea	5	10	10	10	10	2	10	10	11	10
Brazil[3]	15	20-25	20	10	10	25-35	25	30	20	10
Mexico	10	10	10	Free	15	10	10	10	10	10

[1] For all countries except Mexico, tariffs correspond to rates applicable to GATT-member countries, excluding those countries covered by special arrangements (e.g., GSP, U.S.-Canada Free Trade Agreement). Mexican tariffs correspond to rates applicable to all countries except those with which Mexico has special arrangements.
[2] Reflects 1991 tariffs.
[3] Reflects tariffs at end of 1990.

Source: Harmonized Tariff Schedule of the United States (United States); Official Journal of the European Communities (EC); Tarifa Aduaneira do Brasil (Brazil); McGoldrick's Canadian Customs Tariff (Canada); Customs Tariff Schedules of Japan (Japan); Tariff Schedules of Korea (Korea); and Mexican Embassy Trade Office and the U.S. Department of Commerce (Mexico).

declined since 1970 for the United States, the EC, Canada, Japan, Korea, Brazil, and Mexico. Ad valorem tariff rates are approximately 5 to 8 percent in most developed countries, and approximately 15 to 20 percent in many LDCs.[106]

A proposal has been made to eliminate steel tariffs altogether under negotiations currently underway in the GATT Uruguay Round (see discussion under "Outlook").

Trade Measures

Nontariff measures affecting imports, including various market arrangements, have become more prominent as tariffs declined. Nontariff measures encompass import quotas, licensing requirements, foreign exchange restrictions, indirect and direct taxes, preferential procurement regulations, price controls, and other regulations.

In the United States, where tariffs were relatively low throughout the study period, import policies have focused on quantitative limitations and measures affecting import prices. During 1969-74, steel imports from EC countries and Japan, which jointly accounted for about 90 percent of U.S. imports during the period, were subject to voluntary restraints. In 1978, following increases in imports and antidumping complaints, the government implemented a program to monitor prices of imported steel to facilitate detection of sales at less than fair value. This program, called the trigger price mechanism (TPM), was implemented in lieu of the imposition of duties under antidumping cases which had been filed against Japan and certain EC countries. The TPM was suspended on March 24, 1980, when U.S. producers filed a number of dumping complaints, and then reimplemented on October 21, 1980, when these complaints were withdrawn.[107] It was subsequently suspended in January 1982, when the U.S. steel industry filed over 130 unfair trade petitions.[108]

In October 1982, a U.S.-EC arrangement on steel products was reached in lieu of the application of remedies to unfair trade practices under investigation. Under the agreement, the EC committed to limit its shipments to the United States to an average of 5.44 percent of U.S. consumption of specified products. The arrangement also provided for consultation in the event that product shifting occurred between arrangement products and other products not subject to quotas.[109]

As discussed in chapter 1, the current VRAs were negotiated as part of a nine point policy announced by the President in 1984. To bring the agreements into effect, U.S. producers withdrew pending unfair trade petitions and the U.S. Government suspended antidumping and countervailing duties that were in effect on steel products covered by the VRAs.

In the European Community, imports from Japan were limited by agreement after 1971, and imports from Central and Eastern European countries were restricted by 5 member states after 1973.[110] Import restrictions were among the measures introduced under the Davignon plan in 1978. The Commission concluded 15 bilateral restraint arrangements that effectively placed limits on the signatory countries' exports.[111] The limits, will reportedly be terminated in 1992.[112]

In LDCs, the extent to which markets have opened in recent years varies by country. The government of Mexico liberalized restrictions on steel imports following that country's membership in the GATT in 1986.[113] In Brazil, import licensing requirements reportedly have been eliminated, but the Law of Similars, which allows the restriction of imports which compete with domestic products, has not been formally modified.[114]

The government of South Korea announced a number of market-opening measures in April 1987, which reduced both tariffs and quotas. Under the terms of its bilateral consensus agreement with the United States, Korea has committed to eliminate nontariff measures, including a phase-out of all quota programs that relate to steel.[115] On the other hand, the governments of South East Asian countries (Malaysia, Thailand, the Philippines, and Singapore) continue restrictive trade practices, including high import tariffs, import bans, export bans, and discriminatory duty waivers.[116] Such restrictions have sometimes been reduced, however, during times of short supply to compensate for production shortfalls.[117]

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[106] World Steel Dynamics, Steel Survival Strategies Conference, New York, June 1991.

[107] U.S. International Trade Commission, *Summary of Trade and Tariff Information: Iron and Steel*, USITC publication 841, January 1985, pp. 7-9.

[108] Howell, *Steel and the State*, p. 522. Subsidy and dumping margins that ranged from 1.14 percent to 21.42 percent would have effectively excluded a number of European mills from the U.S. market entirely.

[109] Ibid., p. 525.

[110] Ibid., p. 94.

[111] Ibid., p. 79 quoting EC Commission, Communication from the Commission to the Council, "Concerning the Negotiation of Arrangements on Community Steel Imports for 1986," COM(85) 535 final, Oct. 14, 1985.

[112] Staff interviews in Europe, April 1991.

[113] U.S. International Trade Commission, *The Likely Impact on the United States of a Free Trade Agreement with Mexico*, investigation No. 332-297, USITC publication 2353, February 1991, p. 1-2.

[114] *Metal Bulletin*, July 5, 1990, p. 10.

[115] Office of the United States Trade Representative, Press Release, Dec. 12, 1989.

[116] "Steel reflects region's development," *Metal Bulletin Monthly*, March 1984, p. 51; *American Metal Market*, Oct. 30, 1989, p. 4; "Extra tax break sought for steel," *Bangkok Post*, Nov. 19, 1990; *Metal Bulletin*, Nov. 23, 1989, p. 26; *Metal Bulletin*, Sept. 6, 1990, p. 23; and, WEFA Group, *Conquering World Steel Markets*, p. 2.

[117] For example, Taiwan's Board of Trade granted import permits for hot rolled coil during the 1980s, and approved temporary tariff reductions on a number of steel items in December 1989. Department of State, telegram, January 1990.

Export Promotion

Many governments have adopted policies that are designed to support and expand their countries' exports. Such policies have included export tax credits and preferential export financing. In some countries the policies have also included assistance for infrastructure development (such as ports), as well as tax benefits on equipment purchased in support of export production. Steel industries in many countries appear to have benefitted significantly from such policies.[118]

Outlook

Government involvement in the steel industry, particularly in the areas of government ownership, financial assistance, and trade measures, appears to be diminishing, although involvement in the area of regulation, particularly environmental regulation, appears to be increasing. Less interventionist government policies should have a significant effect on investment, production and trade patterns as well as cost competitiveness.[119] To the extent that less government intervention results in a reduction of uneconomic capacity, returns on steelmaking activities in general should rise. Industries in countries that already have low levels of government involvement, such as the United States, should be among the biggest beneficiaries, as they will increasingly compete with firms subject to the same financial and commercial restraints as themselves.

With the structural imbalance in steel capacity and consumption reduced, intervention on the scale that occurred in the 1970s and 1980s seems unlikely. Moreover, the fact that substantially fewer persons are employed by the industry should reduce government incentives to intervene, at least in developed countries.

With respect to government ownership, there is some question as to whether large-scale privatization will be successful. Interest in privatization developed during a period of strong demand for steel and political and economic change in Eastern bloc countries; government policies could change as the economic environment changes. A related problem may exist with regard to financial assistance and nontariff measures; state policymakers may feel compelled to intervene during a downturn for social or economic reasons.

The outlook may be significantly affected by negotiations that are currently underway in the GATT, in which certain countries are negotiating agreements that would prohibit many forms of government assistance, eliminate tariffs, and prohibit measures currently affecting the terms and conditions under which steel can be imported or exported. In broad terms, limitations on production- and trade- distorting measures would create a competitive environment in which all steel producers are essentially subject to the same market disciplines.

[118] For examples of export promotion policies, see chapters on individual countries in Howell, *Steel and the State*. Also see U.S. Department of Commerce findings in countervailing duty cases as published in the Federal Register.

[119] Moreover, privatization may affect the extent to which globalization of the industry continues, as emerging privately-held companies will have new incentives to form financial or strategic alliances with foreign partners.

Environmental Regulation

The production of steel generates significant amounts of waste matter, generating as much as 10 percent of all industrial air emissions and 15 percent of water discharges associated with industrial production.[120] Because of the potential environmental impact, general laws and regulations have been directed at reducing the pollution associated with such waste and, as a result, have affected the industry in a number of areas, including costs, investment, and operations (figure 3-2).

Costs have been affected both by the administrative cost of complying with regulations (e.g. litigation, fines) and the cost of operating and maintaining equipment primarily associated with environmental control. Investment has been affected, as compliance with regulations often requires the purchase and installation of equipment, without which facilities might not be able to comply with standards. Plant site selection and development may be affected, since proposed facilities are often subject to a process in which their environmental impact is closely examined; in some instances such procedures also apply to plant modifications. Environmental regulations that require modifications of steelmaking practices may affect operation levels and practices. The overall effect of such regulations on the industry ultimately depends on several factors: the level of emissions and discharge, the stringency of the regulations and their enforcement, the nature of the penalties assessed for violations, and any assistance governments provide to help defray costs.

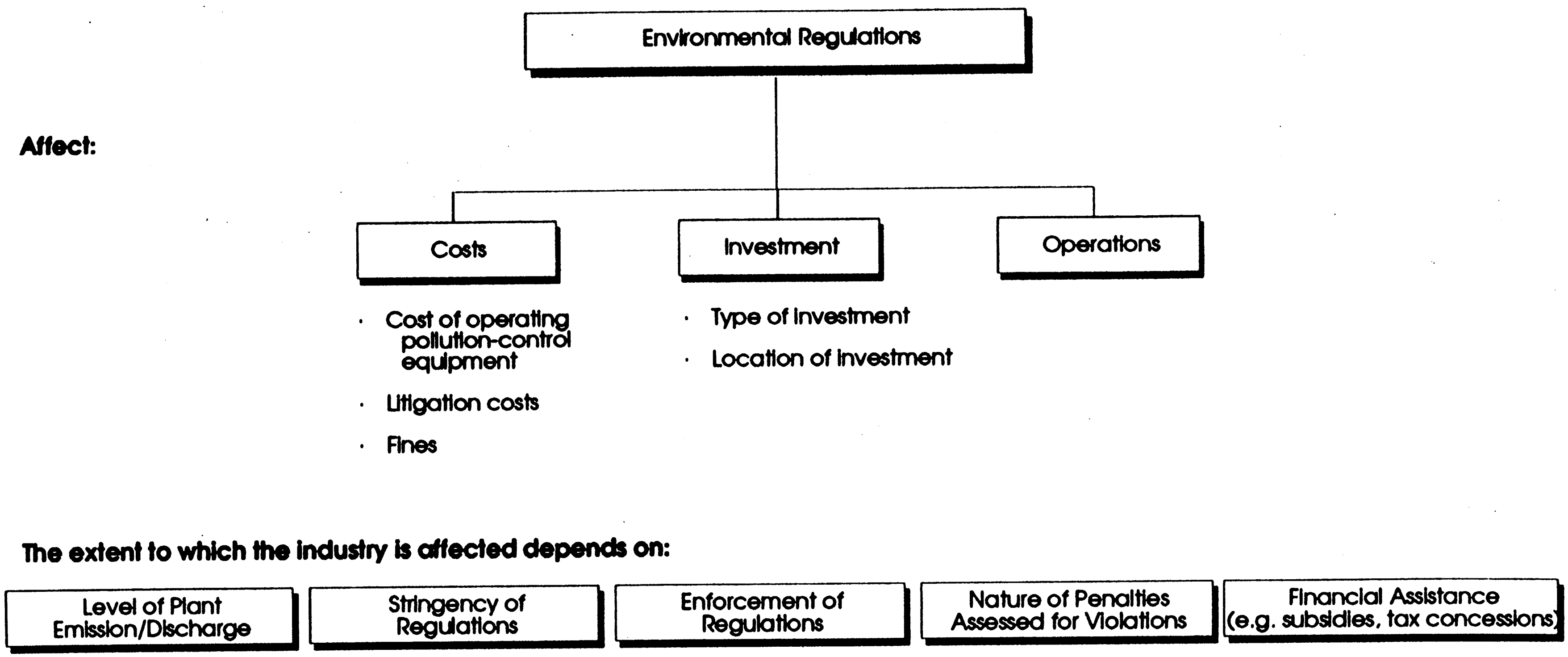
This section examines the following topics: (1) regulations affecting the steel industry internationally; (2) regulation development and enforcement; and (3) effects of regulation on cost and operation of the industry, including the amount of investment devoted to meeting environmental standards.

Discussion of Findings

In general, U.S. federal environmental regulations for air and water pollution standards appear to be broadly comparable with those of other OECD countries and many newly industrializing countries, such as Korea, Taiwan, or Brazil. The greatest discrepancies among national standards appear to be in the area of hazardous waste definition and disposal, where the U.S. industry appears to be subject to more stringent regulation.

[120] Environmental Protection Agency official, interview with USITC staff, February 1991.

Figure 3-2
Impact of environmental regulations on steel industry competitiveness



Also, significant disparity in the stringency of environmental enforcement and in the financing of explicit costs associated with environmental controls may put the domestic industry at a comparative disadvantage in meeting regulatory requirements. U.S. producers appear to have had neither the degree of assistance provided in some other countries, nor the more flexible environment in which other producers often operate.

Background

The production of steel results in the generation of significant quantities of waste that, if not recycled or otherwise used, may be a major source of pollution. For integrated mills, the processes of coking and the benefication of ore are often the most conspicuous waste sources, although the steelmaking process itself (i.e., blast furnaces and steelmaking furnaces) may be responsible for as much as 90 percent of all nonrecyclable waste streams of a given facility.[121] In addition, certain downstream processing activities such as descaling and pickling require acids and oils that become mixed with the large volumes of water necessary for steel production (some 60,000 gallons per ton of steel produced). For minimill producers and for those integrated producers who use electric arc furnaces (EAFs), the initial coking and ore pollution problems are avoided, but EAF dust must be captured and treated to meet environmental standards.

The problems associated with waste treatment are substantial. Despite reductions in emissions by almost 90 percent since the mid-1970s, for example, integrated producers still generate one and one-half tons of nonsteel materials for every ton of steel produced.[122] Additionally, steel producers must treat a variety of potential pollutants throughout the production process (figure 3-3).

Because many byproducts from the steelmaking process can be recycled for use within the plant or to outside consumers, technologies designed specifically for pollution control are often used to contain and treat such waste, generally acting as end-of-the-line abatement measures.[123] Certain technologies installed to increase the efficiency of operations can also have a beneficial secondary effect of lowering emissions; continuous casters and pulverized coal injection systems are two examples of such technologies.

[121] Industry spokesman, American Iron and Steel Institute, USITC staff interview, June 11, 1991.

[122] Testimony of David Boltz, Manager of Environmental Regulatory Affairs, Bethlehem Steel Corporation, before the U.S. Senate, Sept. 26, 1988 and EPA officials, discussion with USITC staff, Mar. 18, 1991.

[123] Abatement technologies are commonly categorized as either end-of-the-line or in-process measures. During 1976-86, expenditures for end-of-the-line control comprised an average of 88 percent of all monies spent. USITC, *Steel Sheet and Strip*, USITC publication 2050, p. 11-108.

Standards

Stringency of Regulations

Few national environmental standards in effect are directed specifically at the steel industry; most are applicable to all industries.[124] In most countries, including the United States, the legal mechanism for setting environmental standards often results in the most stringent industry-or plant-specific requirements being determined at regional or local levels. As a result of local regulatory differences, strict international comparisons of standards are difficult.

Air

A review of national standards affecting air emissions suggests that regulations are broadly comparable between industrialized countries. For many specific pollutants, Japan reportedly falls at the strict end of the continuum, the U.K. and several other European countries at the more lenient boundary, and the United States somewhere in the middle (table 3-8). Such requirements suggest that U.S. steel producers are not distinctly disadvantaged by national air quality standards.

Because approaches to air quality regulation differ, the significance of national differences between regulations depends on the importance ascribed to particular emissions; some nations, for example, place a greater emphasis on SO_2 regulation, whereas others emphasize regulation of NO_2. In addition, differences among nations depend on both the allowable level of emissions and the related frequency limitations (e.g. the number of days per year that such limits could be exceeded). Moreover, different methods may be allowed to meet standards if, for example, emissions are measured for an entire facility, in contrast to being measured from each individual point source of the facility.

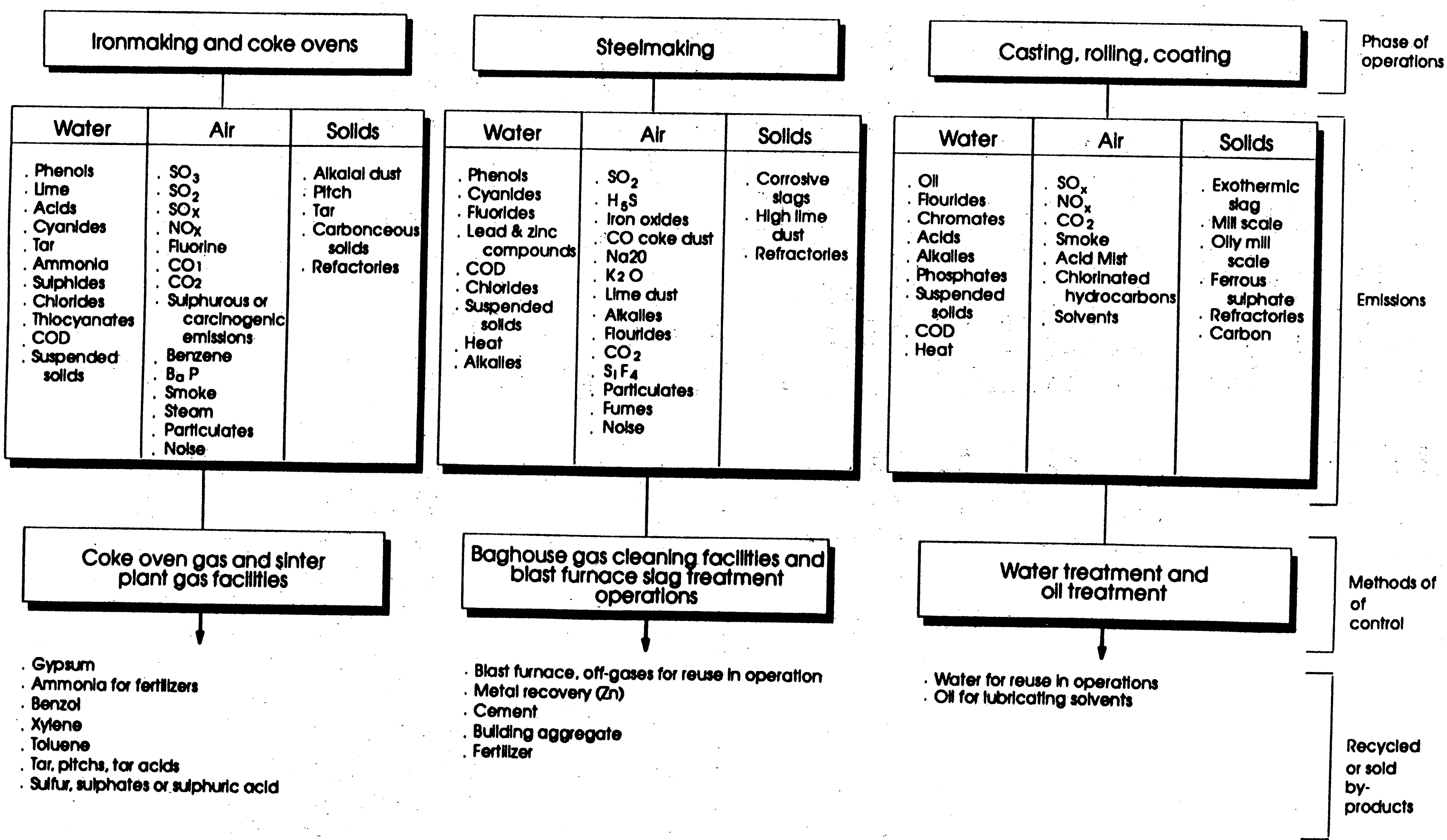
There are indications that national air quality regulations will become increasingly strict in the future. In the United States, for example, provisions of the Clean Air Act of 1990 (CAA) will increase the stringency of U.S. air quality requirements, particularly for coke oven emissions and electric power plants; final promulgation of the regulations by the Environmental Protection Agency (EPA) is due by December 1992.[125] The European Community (EC) is reportedly also considering tightening air quality requirements in conjunction with harmonization of environmental regulations under the EC 92 directives.[126]

[124] One exception in the United States is the U.S. Clean Air Act of 1990, which contains provisions related specifically to coke oven emissions.

[125] It appears that standards for acceptable leakage from coke oven doors will be reduced from the current level of about 12 percent to 8 percent by 1993 and 5 percent by 1995. "Environmental Management in the Metals Industries," *American Metal Market*, Apr. 12, 1991, pp. 1A-11A.

[126] European industry officials, discussion with USITC staff, April 1991.

Figure 3-3
Sources and types of emissions, control technologies, and recovered materials, by process



Source: Adapted from, U.N. Environment Programme, Industry and Environment Office *Guidelines for Environmental Management for Iron and Steel Works*, Paris, 1986.

Table 3-8
Certain air pollutants: Average ambient air quality standards, 1990

Country	SO_2 (ppm)[1]	Particulate (mg/m^3)[2]	NO_2 (ppm)[1]
Japan	0.04	0.12	0.04-0.06
Canada	0.06	0.12	[3]0.10
West Germany	0.06	([4])	0.15
Finland	0.10	0.15	0.10
United States	0.14	0.15	[5]0.13
Italy	0.15	0.30	([4])
Sweden	0.25	([4])	([4])
France	0.38	0.35	([4])

[1] Parts per million.
[2] Milligrams per cubic meter
[3] The Canadian figure is for Ontario; the figure for Saskatchewan is 0.01.
[4] Not available.
[5] Estimated. The U.S. has an annual standard of .053 ppm; at no time, however, can it exceed 0.13.
Source: OECD, Japan Iron and Steel Institute, and U.S. Environmental Protection Agency.

Water

The level of water quality standards is important to the industry because of the large volumes of water and the high toxicity of certain elements used in the steelmaking process. For example, spent pickling liquor, which contains up to 10 percent acid and 12 percent iron, is generated at the rate of 8 to 15 gallons per ton of steel produced. For many companies, this constitutes a pollution problem only second to that of furnace emissions.[127] In addition, water heated during steel production must be cooled and reoxygenated before release.

Currently, comparison of national standards for water pollution is even more problematic than that for air regulations because U.S. water standards are regulated by state authorities and, in most cases, by regional or local authorities abroad. Moreover, existing standards often limit different substances or measure release over different time periods or in different ways. For example, measurement may be done at the end of the pipe or after dispersion in some given volume of water. One review of national standards indicates that differences among OECD countries are relatively minor, and that standards appear to be converging.[128]

Waste

The greatest disparities in international environmental standards appear to occur with respect to the definition and disposal of hazardous waste; in this area, the U.S. industry appears to be subject to more stringent regulation than its foreign a number of countries regulate the generation, transportation, treatment, and disposal of newly created counterparts.[129]

[127] John Wright, "Water, Water Everywhere," *33 Metal Producing*, February 1991.
[128] Resources for the Future, *International Comparisons of Environmental Regulation: Discussion Paper QE90-22-REV*, September 1990, p. 22.
[129] Ibid., p. 24.

With respect to waste definitions,[130] of the six distinct classifications of waste established by OECD member countries, only the United States applies all six criteria (figure 3-4). Moreover, although waste, only the United States assigns liability for past waste disposal practices.[131] While not affecting current (or future) operations, such liabilities constitute a potential cost that could significantly affect the financial performances of companies.

The effect of solid waste control and disposal requirements on the domestic steel industry is unknown at present. It has been estimated that the industry may be responsible for cleaning 35 of the approximately 1,200 sites on the National Priorities List; financial responsibilities have been estimated at $2-10 million per site.[132] Furthermore, Congressional review of the Resource Conservation and Recovery Act (RCRA) in late 1991 or 1992 may modify some definitions in ways that could affect the stringency of waste regulation.[133]

[130] Waste definitions are critical for the steel industry. If national regulations do not distinguish between scrap metals, which are recycled for future use, and other types of waste, steel scrap may be regulated under hazardous waste provisions. Such regulation would have a significant effect on the industry since steel scrap is a necessary input in the production process; minimills may use as much as 100 percent scrap in their mix while BOFs are limited to 30-35 percent.
[131] The Comprehensive Environmental Response, Compensation and Recovery Act (CERCLA, also known as Superfund), is intended to guarantee that abandoned, potentially harmful hazardous waste sites are identified and cleaned up by companies that now own or were once associated with that site. Any company associated with such a site is liable for damage to that site. There are no time or financial limitations on such liability.
[132] U.S. industry executive, interview by USITC staff, June 10, 1991.
[133] By U.S. law, environmental legislation must be reviewed and extended periodically. The same type of review requirements are true in a number of other countries.

Figure 3-4
Classification systems of hazardous wastes used in specified OECD countries
Only United States applies all six criteria

Country	*Type*[1]	*Category*[2]	*Technology of origin*[3]	*Generic grouping*[4]	*Special proscription*[5]	*Applied criteria for proscription*[6]
W. Germany		√	√	√	√	
France		√	√	√	√	
Italy				√	√	
Japan		√			√	√
U.K.		√	√	√	√	√
USA	√	√	√	√	√	√

[1] "Type" refers to the chemical characteristics of a substance, such as whether it is toxic, explosive, or corrosive.
[2] "Category" can be applied to industrial by-products that result from undergoing a specific process. Substances that would be included under the category classification include gas scrubber sludges and fly ashes.
[3] "Technology of origin" refers to substances that are produced after a certain technological process such as petroleum refining or electroplating.
[4] "Generic grouping" includes substances within a subset, such as oily wastes, solvents, and tars.
[5] "Specific proscription" further divides a classification to include substances such as PCBs, dioxin, and lead compounds.
[6] "Applied criteria for proscription" describes the process producing a substance. For example, substances under this heading may be considered hazardous after undergoing a certain extraction procedure.

Source: OECD, *Transfrontier Movements of Hazardous Wastes* (Paris, 1985) and Resources for the Future, *International Comparisons of Environmental Regulation* (Washington, 1990).

Review and reconsideration of waste regulations are likely to occur in other industrialized countries as well. In the Netherlands, for example, measures to be implemented by the year 2000 include 100 percent recycling of steel cans and a reduction in zinc processing.[134] Of particular interest is the implementation of the 1989 Basel Convention, which could significantly limit international trade in scrap and secondary metals by including them in the definition of hazardous waste; at the extreme, such provisions could limit trade in steel scrap.[135]

Development and Enforcement of Regulations

The development and enforcement of environmental regulations significantly affect their ultimate impact. In certain countries outside the United States, such as EC countries and Japan, the process of developing such regulations frequently involves extensive consultation between industry and government officials before their promulgation. Such dialogue facilitates agreement on timetables and methodologies for compliance, and, at a regional or local level, may be tailored for a specific industrial site. In the United States, comment on proposed rules has been allowed, but the relationship between government environmental officials and the steel industry has generally been more adversarial than cooperative and facility-specific adjustments are much less common.[136]

Which level of government oversees environmental regulation may also make a difference. In certain steel-producing countries, such as Brazil and those in Eastern Europe, state and local power has reportedly been weak. However, enforcement is increasing as local political parties concerned with environmental issues emerge and as the consequences of past negligence become more evident. In Brazil, local authorities forced a 5-day closure of the country's third-largest mill, CST, because of high levels of air-borne emissions;[137] reportedly, some Central European plants may be closed because of associated pollution.[138]

The promulgation and enforcement of environmental regulations seems to have been more expensive for the U.S. steel industry than for most foreign producers, both in terms of actual dollars, and

[134] *American Metal Market*, Sept. 20 and 27, 1990, and Oct. 10, 1990.
[135] U.S. government officials, discussion with USITC staff, January 1991.

[136] Since 1979 the U.S. steel industry has been assessed over $31.8 million in federal fines for environmental non-compliance and as recently as 1990, citations for environmental violations were issued by the EPA to several steel companies; state environmental agencies also cited a number of mills for violations. EPA official, discussions with USITC staff, May 1991, and Kopp, Portney, and De Witt, *International Comparisons of Environmental Regulation*, Resources for the Future Discussion Paper QE90-22-REV.
[137] Michael Kepp, "Brazil steel urged to spend $320M to curb pollution," *American Metal Market*, Nov. 16, 1990, p. 4.
[138] [* * *].

manpower spent on litigation and fines.[139] This suggests that the enforcement process in the United States may be particularly costly to the domestic industry relative to its foreign competitors.

Effects on Investment and Costs

Although useful for comparison among steel-producing countries, data on pollution control expenditures may be misleading. Companies differ in how they calculate the costs associated with environmental compliance, and there are a variety of different types, including operating costs, investment and training costs, permit costs, and costs associated with litigation and enforcement. An analysis of comparability must also consider the impact of such mitigating variables as the timing of expenditures or the availability of government financial assistance in the form of subsidies or tax concessions.

Investment

The costs of investing in pollution control equipment may not be immediately apparent, depending on the age and type of facility. For most of the older production facilities located in the United States and the EC, mills were retrofitted with pollution control equipment, making the cost of installing controls obvious. However, for producers with comparatively modern facilities (such as those in Brazil, Korea, and Taiwan) such costs must sometimes be estimated as a percentage of investments because new production equipment incorporates pollution abatement mechanisms in the design (e.g., a new coke battery or basic oxygen furnace will already contain air filtration systems).[140] Moreover, some percentage of initial expenditures for abatement equipment or facilities may be recouped over time if the equipment processes recyclable waste for use within the plant or, in some cases, for outside sale. The reported value of materials recovered by the domestic industry in 1988, for example, represented about 3 percent of pollution control operating costs.[141]

In addition to the age of equipment, the size and mix of facilities that constitute a nation's steel industry affect the cost required to comply with national standards. For example, integrated mills, which use iron ore, coking coal, and scrap, entail far more processing of material and have dictated more costly abatement measures than has been the case for minimills, which are almost completely scrap-based. Despite this, minimills and integrated producers currently devote about the same percentage of net sales to pollution control expenditures. In 1989, such expenditures represented 0.4 percent of net sales for U.S. integrated producers, 0.3 percent for minimills, and 0.2 percent for specialty producers.

In terms of international comparisons, available data suggest that expenditures on a per-ton basis or as a percentage of total capital expenditures were not significantly higher for U.S. producers than for their foreign counterparts.[142] An analysis of investment since 1977 indicates that environmental expenditures by U.S. steel producers peaked at about 27 percent of all capital expenditures in 1979 (figure 3-5); and by Japanese producers, at 21 percent (in 1976).

Operating Costs

In addition to initial purchase and installation expenses, companies also have costs associated with maintaining and monitoring pollution control systems (table 3-9).

In the United States, the costs for operation and maintenance of pollution control facilities have increased, rising from about \$7 per ton of steel produced in 1978 to a current level of \$10 to \$20 per ton in recent years;[143] this represents about 5 percent of steel production costs. In contrast, steel producers in Japan and Europe report that during this time period, operating costs have consistently been approximately \$14 to \$17 per ton, indicating a higher level of expenditures over time for mills that meet standards, although current costs appear to be comparable to those in the United States.[144] Like investment expenditure estimates, operating expenses may not be comparable. Discussions with EC steelmakers, for example, suggests that industries in some countries define such expenses broadly, including salaries of staff associated with maintenance; other firms define costs more narrowly.

Other Issues

Permits

Other costs connected with environmental regulations include expenditures associated with securing required permits prior to receiving permission to build new facilities. The estimated cost of this process in the United States is 3 to 5 percent of the total investment cost of a project.[145] Minimill operators in California have also stated that more

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[139] *Improving the Enforcement of Environmental Policies*, OECD Environment Monographs, January 1987.

[140] U.S. industry officials estimate, for example, that one scrubber system accounts for about 15 percent of the initial cost of a BOF. Steel industry executive, USITC staff discussions, June 5, 1991.

[141] For example, EAF dust, which contains over 15 percent zinc, is processed to remove the trace metal, which can then be sold. Steel slag is often processed and sold as building material. Water, which serves as a coolant in many steel processes, can be cleaned and recycled. See Census Bureau, *Manufacturers' Pollution Abatement and Capital Expenditures and Operating Costs*, Current Industrial Reports, MA 200(88)-1, 1990.

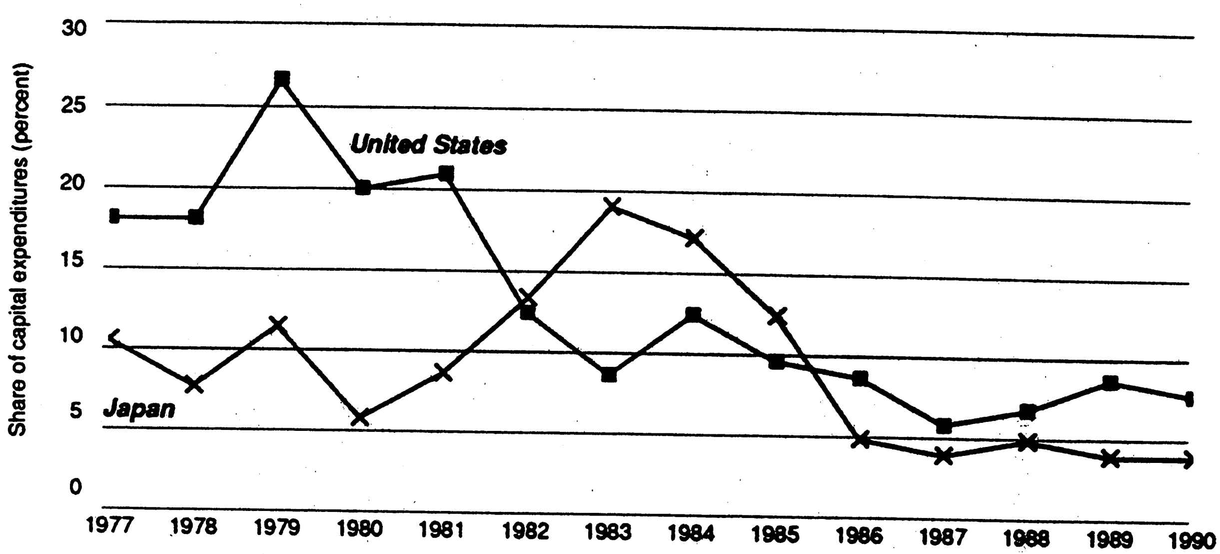
[142] Congressional Budget Office, *Environmental Regulation and Economic Efficiency*, March 1985.

[143] E.F. Young, "Steel and the Environment," presented to the Mineral Economics Symposium, Nov. 30, 1989.

[144] International Iron and Steel Institute, *The Electric Arc Furnace*; European industry officials, interviews with USITC staff, April 1991.

[145] Industry spokesman, American Iron and Steel Institute, interview with USITC staff, May 17, 1991.

Figure 3-5
Steel pollution control expenditures as percent of total capital expenditures in the United States and Japan, 1977–90
Difference narrows by mid-1980s



Source: AISI statistical yearbooks, Japan Iron and Steel Federation, and Japan Steel Information Center.

Table 3-9
Environmental control equipment: Certain types, purpose and cost, 1991

Area affected/ type of equipment	*Purpose*	*Estimated initial cost*	*Estimated operation and maintenance*
		Million dollars	*Dollars*
Coke Ovens:[1]			
Dust and benzene emission control	Reduces air emissions	}	} .85-1 million
Door system and pushing emission controls	Reduces air emissions	6.5	
Battery system design	Reduces air emissions	4.0	
By-products plant for water treatment, sulphur emission control	Collects benzene; recovers by-products	7-10	([2])
Blast furnace/EAF:			
Dust catcher and scrubber	Removes large particles	([4])	
Bag house and gas suppression system[3]	Collects dust	15-20	6/ton of steel produced
Tapping covers	Recovers gases	1.5	200,000
BOF:			
Wet scrubber	Reduced air emissions; treats sludge	3-4	500,000

[1] Estimates are for controls on a new coke oven. Retrofitting older ovens may require higher costs.
[2] Not applicable. Maintenance is minimal and primarily involves replacement of seals and covers.
[3] Estimate is for a 150 ton furnace.
[4] May be included in original equipment.
Source: U.S. industry executives and equipment suppliers, USITC staff interviews, June 1991.

rigorous environmental requirements along the West Coast have precluded further expansion in that region.[146] Information is limited about comparable requirements for foreign producers.

Timing

The timing of required expenditures for pollution abatement may exacerbate other financial problems. Specifically, regulations may require a firm to make large expenditures at a time when it is already in poor financial health, or when capital is needed to modernize facilities or to invest in other critical areas such as research and development or training in order to remain competitive. For example, in the United States, the 1983 closure of Kaiser steel in Fontana, California, was reportedly due in part to costs associated with compliance with environmental regulations concurrent with poor financial returns.[147]

Financing

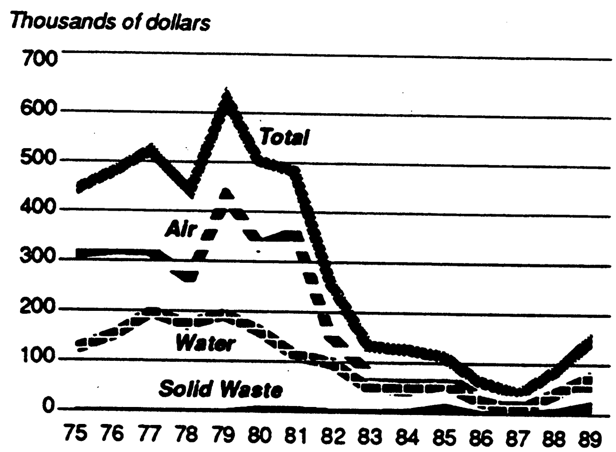
Assistance is provided by governments in different ways and to different extent, including tax concessions, accelerated depreciation, low interest loans, and government grants for abatement equipment and for research and development related to pollution reduction. In Japan, for example, the industry reportedly benefitted from accelerated depreciation of equipment, research and development subsidies, and over $1 billion in low-interest loans granted by the Japan Development Bank.[148] Similar types of government assistance was provided to the German, Austrian, and Taiwanese industries.[149] In the United States, the Investment Tax Credit, effective from 1962 to 1986, allowed a 7 to 10 percent writeoff of capital expenditures; most steel producers applied this provision to the installation of pollution control equipment.[150] In some cases individual states also offer financial assistance. For example, when the costs associated with retrofitting a steel facility appeared prohibitive for Laclede Steel Company, the State Development Authority of Illinois provided low interest, tax-exempt financing to build a new facility.[151]

Outlook

For both waste and air standards, a convergence of national regulations within regions seems probable. Such movement is apparent in discussions related to the EC 92 common market and regional trade agreements, such as the North American Free Trade Agreement. A working group has been set up to facilitate the latter by establishing closer environmental cooperation between the United States and Mexico.

At the same time, it is anticipated that revised legislation will require steel producers in the EC and the United States to increase the levels of investment for control of air emissions and waste, a reversal of the trend in recent years (figure 3-6). It has been estimated, for example, that expenditures by U.S. steel producers to meet requirements of the 1990 amendments to the Clean Air Act could add $17 per ton of raw steel, or 3 percent of the cost of production.[152]

Figure 3-6
U.S. expenditures for pollution control, 1975-89
Fell rapidly in 1980s, but climbing again



Source: *American Iron and Steel Institute, Annual Statistical Reports.*

Technology

Steelmaking technology[153] encompasses a broad range of equipment used to produce finished steel products from various raw materials, as well as the knowledge, skills, and abilities of the people who operate that equipment.[154] As discussed in Chapter 2,

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[146] James Todd, presentation to American Metal Market conference, Los Angles, December 1990.

[147] USITC, *Western U.S. Steel Market*, USITC publication 2165, p. 1-1.

[148] [* * *].

[149] [* * *].

[150] Under this tax provision, expenditures for pollution control equipment could be amortized but almost all pollution abatement expenditures were treated instead as capital expenditures, which qualified for investment tax credits. Steel industry executive and tax legislative analyst, discussion with USITC staff, Jan. 29, 1991.

[151] Francis J. Lavoie, "Dealing With Chemical Waste," *33 Metal Producing*, February 1991, p. 28.

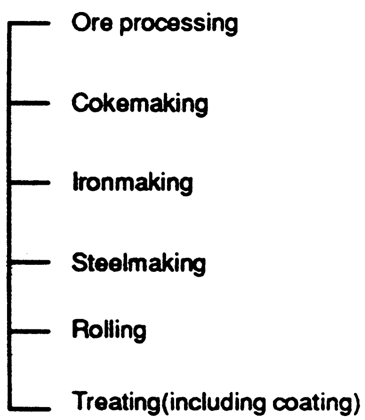
[152] These figures may reflect only a portion of required expenditures; there may also be indirect costs associated with the effect on coal fired utilities' costs of acid rain provisions. World Steel Dynamics, *Cost Monitor #13*; David Cantor, Congressional Research Service, telephone interview by USITC staff, Mar. 5, 1991.

[153] See appendix F for discussions on current and emerging steelmaking technologies, as well as their present importance and expected impact.

[154] The use of steelmaking equipment requires that the operators continuously monitor, control, and adjust the process. The skill with which this is accomplished can lead to divergences in the technical performance of two plants with identical equipment, or even between shifts at one mill.

current technology for steel production includes two primary processes, integrated and nonintegrated, and can be separated into six major processing steps. The integrated process typically includes all six steps, while the nonintegrated process uses scrap as its raw material, bypassing the ore processing, cokemaking, and ironmaking steps (figure 3-7).

Figure 3-7
Major steelmaking process areas



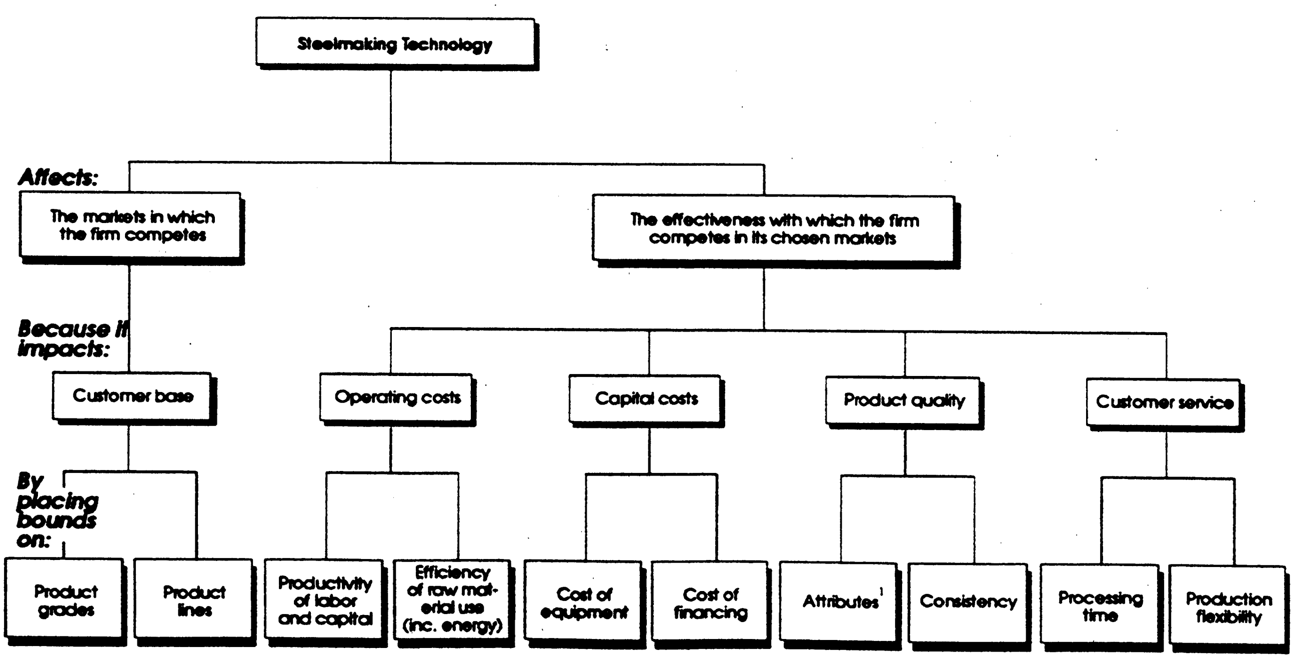
The steelmaking technology possessed by a firm, as embodied in its production equipment, affects its competitive stance in two ways (figure 3-8). First, technology delineates the firm's customer base by determining the types of products that can be produced, significant since steel is produced in a wide variety of shapes, sizes, grades, and tolerances. Second, the type and condition of a firm's production equipment determine how effectively a firm competes within its chosen markets by influencing capital and operating costs, product quality, and customer service.

The purpose of this section is to discuss: (1) the nature and significance of principal developments in steelmaking technology in the major processing areas during the past 20 years; (2) the extent to which key technologies have been adopted in steel-producing countries; (3) the effect of technology on industry competitiveness in principal producing countries; and (4) the outlook. Many of the comparisons are international in scope; special attention, however, is given to the U.S. position.

Discussion of Findings

Changes in steelmaking technology over the past twenty years have been evolutionary in nature, involving the modification and improvement of basic processes. The primary factors driving equipment development and application have been increased efficiency and product quality improvement. The changes that occurred have tended to increase the level of technology employed to produce steel and to permit greater specialization in the industry. With respect to the latter point, companies with more sophisticated facilities often produce products that can be differentiated from those produced by competitors that lack similar equipment.

Figure 3-8
Steelmaking technology's relationship to competitiveness



[1] Includes internal quality, dimensional accuracy, surface quality, and properties (tensile strength, ductility, corrosion resistence, etc.)

The U.S. industry as a whole continues to lag behind many of its principal competitors, not only in installed production technology but in capital spending, though certain U.S. facilities and firms have improved their relative competitiveness in a global context. Certain firms are effectively adopting new technology, especially in the areas of casting and process coupling.

Major domestic integrated producers, together with their foreign joint venture partners, have invested considerable sums in new technology in recent years to enhance their ability to produce more sophisticated, higher value- added products. While these producers have improved their productivity and product quality, the modernization has often been piecemeal, and many plants contain both state of the art operations and antiquated facilities.

The smaller integrated producers have generally focused on more commodity type products. In many cases, these firms have been spun off from a major producer or reorganized in a way that has reduced input and capital costs; such firms are commonly referred to as reconstituted mills. Modernization efforts at such facilities have been varied, with some firms actively upgrading their operations and others pursuing more modest programs. Leading firms in the minimill sector have moved into higher value-added products and built new capacity as well as upgraded existing facilities. The scope of modernization efforts appears to have been related to product value, with firms that are pursuing higher quality niches more active in adopting both cost-reducing and quality-enhancing technology.

Major Trends in Steelmaking Technology

During the past two decades, several major trends were evident in the evolution of steelmaking technology. These trends included process refinement, decreasing minimum efficient scale, shifts in process discontinuities, increasing applications of computer monitoring and control, and converging of the integrated and nonintegrated processes. A significant result of these trends has been a reduction in the amount of labor required to produce steel mill products. Such technologies as continuous casting and the application of computer control technology in steelmaking operations have been at the forefront in reducing the labor requirements of the industry.[155]

The changes that occurred in technology were driven by the following major factors:

- Efforts to minimize costs;
- Customer demands for products with enhanced attributes;
- Governmental regulation (e.g. environmental standards); and
- Discoveries that have improved the understanding of metallurgical interactions.

Firms must continually pursue technology that lowers production costs to maintain competitiveness. The shift toward smaller scale technology is driven in large part by the existence of significant capital cost advantages for the small scale production of many steel products. For example, the current cost of a state-of-the-art, 4-million metric ton-per-year integrated facility in an OECD country is estimated to be between $4 billion and $8 billion dollars ($1,000 to $2,000 per ton of capacity), while a state-of-the-art minimill (500,000 metric tons) costs about $250 million (or $500 per ton of capacity).[156] Even for existing plants, capital requirements are lower for smaller facilities. The annual reinvestment requirements for an integrated plant have been estimated at $40 per ton of capacity compared to minimill requirements of $15 per ton.[157]

With respect to customer demands, steel companies, particularly those competing in the higher value-added products, are being asked over time to provide more "value," in terms of steel products that are less expensive, stronger, more durable, and cheaper to fabricate.[158] Addressing these demands often entails the addition or replacement of production machinery or the improvement of existing processes; such investment, of course, tends to raise costs. Thesechanges are also required to maintain or enhance the competitiveness of steel vis-a-vis alternative materials.[159]

As governments around the world have increased the regulation of pollutants, the steel industry has had the option of either adding pollution-control technology or shifting to technology that is inherently less polluting. While investments are made throughout the production process with the purpose of improving process efficiency, it has been suggested that much of the investment in technology in the industry's "hot end" (particularly cokemaking and ironmaking) has been driven by environmental considerations.[160]

Finally, as the global steel industry improves its understanding of pyrometallurgical, solidification, and material boundary reactions, steelmaking technology is

[155] David H. Clark, "Computer Process Control in the Steel Industry," presented at the International Iron and Steel Institute meeting, Toronto, Canada, October 1981.

[156] Organization for Economic Cooperation and Development, *The Role of Technology in Iron and Steel Developments*, Paris, 1989, p. 49.

[157] Marcel Genet, "How to be competitive in steel in the 1990's," Metal Bulletin's 3rd European Steel Conference, Munich, Oct. 30, 1989.

[158] Frank Fitzgerald, presented at "Steel Survival Strategies V," New York, June 27, 1990.

[159] Customers of steel products do not necessarily demand steel, but rather require materials that fit certain performance characteristics. Over the past 20 years, the field of material science has produced a wide range of new or improved materials, such as plastics, composites, ceramics, and polymetallic alloys that compete in end use applications with steel.

[160] [* * *].

adapted or developed to take advantage of that knowledge. The compartmentalization of the raw steelmaking phase, much of the work on net shape casting, and the increase in electrolytic coating facilities are all related to an improved understanding of how iron and its alloys interact under given circumstances.

Following is a discussion of major trends in steelmaking technology, as well as examples of technological changes supporting the trends.

Process Refinement

The major technologies used to produce steel— blast furnaces, the basic oxygen process, electric arc furnaces, ladle metallurgy facilities, continuous casting, and rolling mills— were all developed prior to 1970. Throughout the 1970s and 1980s, these principal technologies have been modified and improved, contributing simultaneously to significant improvements in productivity[161] and product quality over the period.

Coal Injection

A major refinement in the operation of blast furnaces has been the development of coal injection systems. Coal injection systems permit the substitution of powdered coal for coke, natural gas, and fuel oil. The technology was developed and first introduced by Armco, a U.S. steelmaker, in 1963. Adoption of this technology is primarily predicated on relative costs for coke, coal, and fuel oil, although environmental considerations play a part as well. Typical estimates of cost savings accruing from adoption are in the neighborhood of $10 per ton of iron.[162]

The U.S. steel industry has lagged behind its competitors in most industrialized countries in the adoption of this technology. In Japan and Western Europe, approximately half of the blast furnaces utilize coal injection capability, while Armco's two installations are the only current U.S. facilities.[163] The lower rate of adoption in the United States appears to be attributable to historically lower prices for oil, natural gas and coke in the United States than in Japan and Europe. Changing fuel-supply economics and tighter environmental regulations have now increased U.S. steelmakers' interest in coal injection, however, and most major U.S. firms indicate plans to add coal injection in the near future.[164] It is anticipated that systems will be in place in nearly all primary domestic blast furnaces by the mid- to late-1990s.[165]

Basic Oxygen Furnace

The basic oxygen furnace (BOF) has replaced the open hearth furnace as the primary method of integrated steelmaking. In 1970, the U.S. industry lagged behind the Japanese in adopting this technology, but generally led other major producing countries in this area. By 1989, however, developed countries' use of BOFs was comparable, significantly exceeding many industries in developing and eastern European countries (table 3-10).

The major refinement to basic oxygen furnace (BOF) steelmaking has been an improvement in oxygen-blowing practices. In traditional BOFs, oxygen is blown only through a lance inserted in the top of the furnace. As oxygen steelmaking technology has improved, systems for injecting the oxygen in the side and bottom of the vessel were developed. Such systems, alone or combined with top blowing, result in improved stirring and homogeneity of the bath, leading to improvements in steel quality and productivity.

Although the U.S. steel industry's efforts to install advanced blowing techniques have not kept pace with its major competitors (figure 3-9), the industry's position should soon improve as companies are now actively installing the new techniques.[166]

Electric Furnace

Electric arc furnace technology has undergone numerous modifications leading to increased capacity and productivity, as typical heat times[167] have been cut from 2 hours in 1960 to 70 to 80 minutes, at present.[168] While some of this decrease is due to the increasing practice of finishing the refinement phase in ladles, most of it is due to improved furnace technology.

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[161] It should be noted that the bulk of the economic benefits of an innovation does not usually accrue with its initial adoption. Indeed, the greater economic benefits of a new technology typically accrue from incremental improvements in operating practices and through small equipment modifications. See, for example, J. Enos, "A Measure of the Rate of Technological Progress in the Petroleum Refining Industry," *Journal of Industrial Economics*, vol. 6, June 1958, pp. 180-197; Gerhard Rosegger, "On 'Optimal' Technology and Scale in Industrialization: Steelmaking," *Omega*, vol 3, No. 1, January 1975; and Nathan Rosenberg, "Factors Affecting the Diffusion of Technology," *Explorations in Economic History*, vol. 10, No. 1, (Fall 1972), pp. 3-33.

[162] L.M. Cloran and L. Ulveling, cited in George McManus, "Coal Gets a New Shot," *Iron Age*, January 1989, p. 38. Also, M. Sorenson, Manager of Raw Materials and Primary Production, Inland Steel Co., cited in Allen Abrahams, "Substituting Coal for Coke," *American Metal Market, Steelmaking Supplement*, September 1989, p. 10A.

[163] Marshall Mazer, "US steelmakers turn to coal injection," *Metal Bulletin Monthly*, July 1990, p. 67, and Memorandum from R. Unsworth, Industrial Economics Incorporated, to J. DeMocker, U.S. Environmental Protection Agency, dated Jan. 4, 1990.

[164] USITC, *Steel Industry Annual Report*, USITC publication 2316, p. 25.

[165] Mazer, "US steelmakers," p. 67.

[166] J. Stone and E. Michaelis, "L-D turns to combined blowing for higher quality," *Iron and Steel Engineer*, September 1990, p. 40.

[167] Heat time is measured from one furnace tap to the next. To tap a furnace means to empty a batch of molten steel into a ladle.

[168] Wallace Huskonen, "EAF Progress Round-up," *33 Metal Producing*, December 1988, p. 27.

Table 3-10
Steelmaking: Basic oxygen furnace share of nonelectric furnace production

(In percent)

Country	*1970*	*1989*
Developed countries:		
Japan	95.0	100.0
West Germany	61.9	100.0
United States	56.9	91.9
Italy	52.9	100.0
United Kingdom	39.9	100.0
Canada	37.0	[1]100.0
France	32.6	100.0
Developing countries:		
Brazil	45.8	96.9
South Korea	(2)	100.0
Taiwan	(3)	100.0
China	0.0	[4]73.1
India	0.0	46.3
Eastern Europe and Soviet Union:		
Romania	31.7	63.7
Czechoslovakia	20.5	53.0
Soviet Union	19.0	39.4
Poland	13.7	52.9
World Total	45.7	76.3

[1] Canadian basic oxygen production as a percentage of total Canadian integrated production for 1989 cited in The WEFA Group, *Conquering World* Steel Markets: Forecast and Analysis through 2000, *vol. 2.*

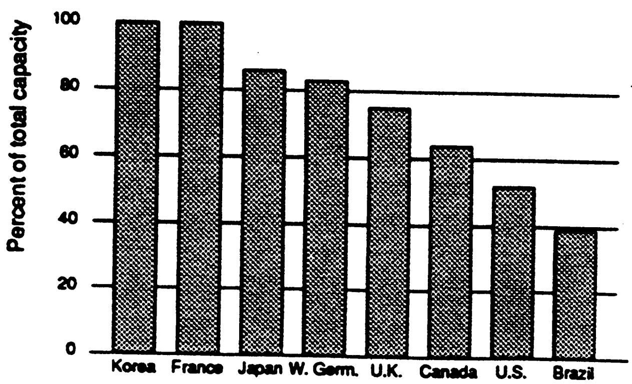
[2] Not available. Information collected by the U.S. Bureau of Mines indicates the presence of two open hearths and two basic oxygen furnaces in South Korea in 1971.

[3] Not applicable. Taiwan's integrated steel industry developed in the early 1970s.

[4] Figures for China's steel production during 1989 provided in The WEFA Group, *Conquering World Steel Markets: Forecast and Analysis through 2000,* Volume 3.

Source: Data for 1970 cited from British Steel Corporation, *International Steel Statistics World Tables*, Year 1974. Except as noted, data for 1989 cited from International Iron and Steel Institute, *Steel Statistical Yearbook 1990.*

Figure 3-9
Basic oxygen furnaces using advanced blowing technology, 1990: U.S. steel industry lags behind competitors



Source: "1990 Worldwide LD Capacity," *Steel Times*, May, 1990.

Other improvements include: doubling of maximum electric power ratings; the introduction of auxiliary burners, oxygen lances, and bottom tapping furnaces; development of water cooled roofs and walls; and pre-heating of scrap. These improvements to a simple furnace could raise capacity by over 40 percent.[169] Electric arc furnace technology is relatively advanced in the United States, as the nonintegrated segment of the industry has actively adopted new EAF improvements, such as water-cooled panels, oxygen blowing, high and ultra-high power transformers, and, to a lesser extent, bottom tapping. Scrap preheating, however, although widely practiced in Asia and Europe, is still relatively uncommon in the United States.[170]

Continuous Casting

Continuous casting is a technology that reduces both capital[171] and operating costs, and improves productivity, yield, and quality. The U.S. industry, although having narrowed a substantial gap between itself and its principal competitors, still lags behind many major industries in the adoption of continuous casting.[172] This backwardness may, however, prove to be beneficial to certain firms in the industry now installing such equipment, since recently installed casting machines are significantly more advanced than earlier models. With respect to casters currently in use, an estimated 15 to 20 percent of U.S. casters are apparently bordering on obsolescence.[173] Upgrading these casters may be possible with selected modifications. For example, the first slab caster installed in the U.S. was recently renovated at the relatively low cost of $75 million, with significant improvements in operating characteristics.

Rolling Mills

Major refinements have also been made in rolling mill technology, aimed at product consistency and improved productivity.[174] Although the basic form of rolling mills is virtually unchanged, optimization of the rolling operation has resulted in a wide array of refinements being applied to existing mills. U.S. steelmakers have applied many of these improvements, especially major integrated flat-rolled producers.

[169] Richard Fruehan, "A Non-technical Introduction to Electric Furnace Steelmaking," *Iron and Steel Maker*, June 1989, p. 40.

[170] Ibid.

[171] The cost of a new continuous casting facility is lower than the cost of new facilities to produce semifinished products by the ingot cast method.

[172] See discussion under the heading "Shifts in Process Discontinuities" and figure 3-10.

[173] Jo Isenberg-O'Laughlin, "Con Casting: Red Hot and Rising," *33 Metal Producing*, January 1991, p. 20.

[174] Wallace Huskonen, "Rolling Mill Update '89," *33 Metal Producing*, April 1989, p. 15.

Virtually every flat-rolling mill in the country has undergone or is undergoing modernization programs.[175] However, because of the variety of possible modifications and improvements that can be applied to rolling mills,[176] the process of rolling mill modernization is a continuous one and in several mills the completion of one modernization program simply signals the start of another.[177] The array of possible improvements and the variety in the types of mills themselves render a qualitative comparison between U.S. mills and those of foreign competitors difficult.[178]

Decreasing Minimum Efficient Scale

Technological change has also taken the form of decreasing minimum efficient scale, allowing the economic production of steel products at significantly smaller plants, thereby reducing the amount of capital needed to generate a dollar of sales.[179] The most significant decreases in minimum efficient scale have been in the production steps of semifinished shapes, which have been achieved through the use of electric arc furnaces and continuous casting technology. The scale advantages for rolling and finishing operations, while positive, were already relatively low,[180] and posed less formidable barriers to small scale production.

Nonintegrated Steelmaking

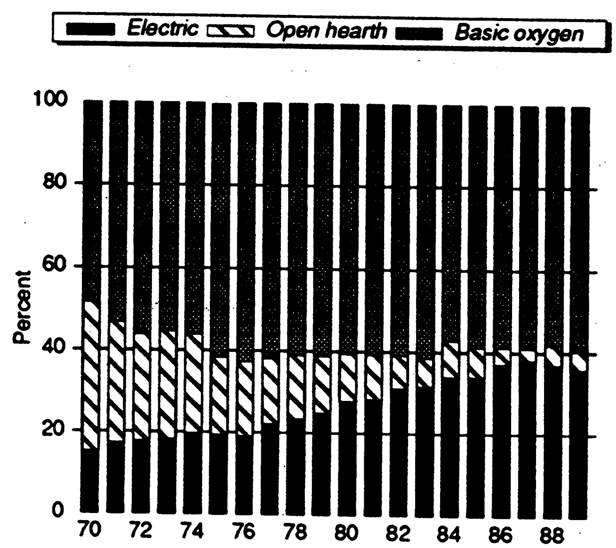
Decreasing minimum efficient scale has facilitated investment in the steel industry because of lower financing requirements and has led to an increase in the nonintegrated minimill segment in many industries around the globe. In several product lines, such as bars, rods, and light structural shapes, this small scale route to the production of steel products has proven to be the most competitive technology.[181] Economic, small scale production of other products, such as heavy structurals, plates, and sheets has also been accomplished by several nonintegrated facilities. This trend has served to decrease industry concentration while increasing competition in steel markets around the globe.

The U.S. industry has been one of the most active countries with respect to adopting electric furnace steelmaking. Throughout the past two decades, electric furnaces' share of production has grown fairly consistently, while open hearth production has fallen precipitously and the share of production accounted for by BOFs has been remarkably consistent (figure 3-10). The U.S. industry produces a greater share of its steel through the EAF process than any of its major competitors (figure 3-11).

Continuous Casting

Near-net-shape casting,[182] the casting of crude steel in a shape approximating its final form, has also

Figure 3-10
U.S. steel production, by process, 1970-89
Share of EAF steelmaking rises, while BOF steelmaking share remains steady



Source: American Iron and Steel Institute.

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[175] Charles E. Gray, cited in George McManus, "Hot strip Mills, The Hottest Spot in Steel's Modernization Effort," *Iron Age*, December 1988, p. 20, and Wallace Huskonen, "Rolling Mill Update '89," p. 15.

[176] For example, Clecim Inc., an equipment manufacturer, identified 28 major areas of possible improvement for hot strip mills at the March 1989 Cleveland District meeting of the American Institute of Steel Engineers.

[177] Steel industry officials, interviews by USITC staff, March and April 1990.

[178] The dimensional accuracy and consistency of steel products is directly related to rolling mill performance. Information gathered for other sections of this report and preceding reports indicate that U.S. performance in this area has improved relative to major offshore competitors.

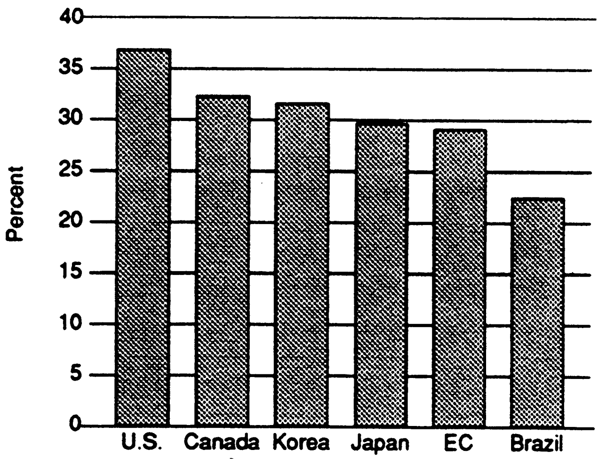
[179] Peter Marcus and Karlis Kirsis, "Accelerating Change Threatens Traditional Producers," *World Steel Dynamics*, June 18, 1991, p. 41.

[180] Donald Barnett and Louis Schorsch, "Improving Performance: Ways and Means", in *Steel: Upheaval in a Basic Industry*, (Ballenger, Cambridge, MA, 1983), p. 170-203.

[181] Donald Barnett and Robert Crandall, "The Competitive Position of Minimills," in *Up from the Ashes: The Rise of the Steel Minimill in the United States*, (Brookings, Washington, D.C., 1986), p. 18-35.

[182] Near-net-shape casting in the steel industry has been focused on thin slab casting, strip casting, and beam blank casting.

Figure 3-11
Electric furnace steelmaking share of total production, by selected country and region, 1989



Source: International Iron and Steel Institute.

lowered scale requirements for certain products, such as sheets or heavy structural products. The minimill and specialty sectors of the U.S. industry are leading the world in the commercialization of such technology. The first commercial applications of thin slab casting and strip casting technology have been undertaken by two domestic companies, Nucor and Allegheny-Ludlum. While the long-term impact of these technologies may be subject to debate, many factors indicate future growth in small scale sheet production.

Beam blank casting, which permits small scale production of most sizes of structural shapes, has been installed by several U.S. minimills resulting in costs estimated to be $40 to $50 lower per ton (approximately 10-15 percent) than traditional routes.[183] Several U.S. minimills using this technology have entered or increased their participation in the structurals market in the past few years, resulting in a reduction in integrated mill participation (or, in one case, total withdrawal). The competitiveness of these new mills is not limited to the domestic market. U.S. exports of structural steel increased from approximately 2 percent of shipments in 1988 to 5 percent in 1989 and 10 percent in the first five months of 1991, as these new, low cost facilities penetrated international markets, including those in Western Europe and Japan.

Shifts in Process Discontinuities

As steelmakers and equipment manufacturers attempt to improve steelmaking technology, the nature and type of discontinuities within and between process steps have changed. Individual process steps, evolving from a batch approach to continuous forms, have both grown and declined.

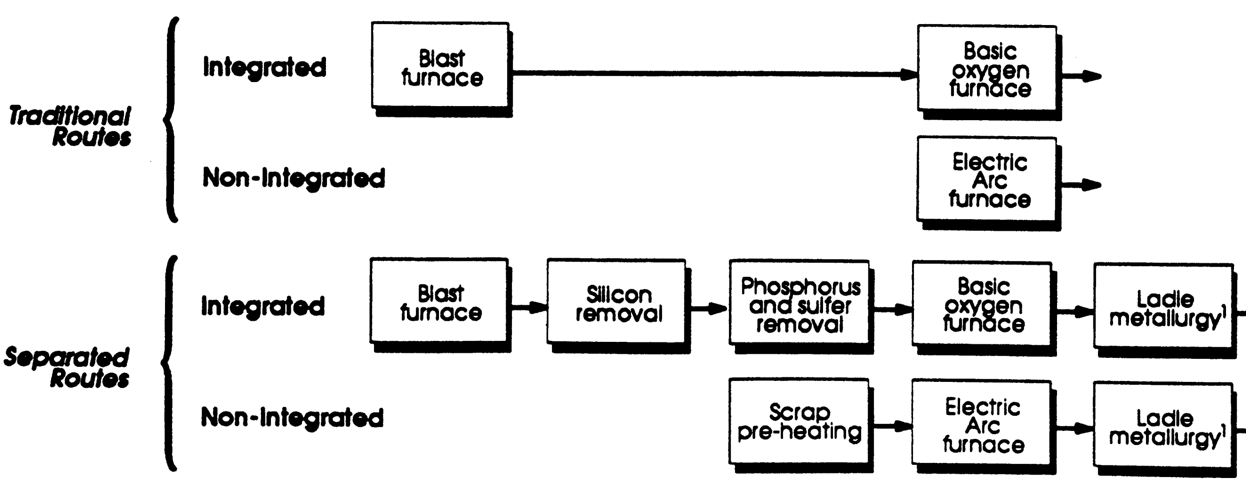
The number of processing steps up through the production of molten steel has actually increased (figure 3-12). Steelmaking furnaces alone used to be counted on to provide an acceptable product for casting, but pretreatment of molten iron or scrap and post treatment of liquid steel now allow more efficient use of steelmaking furnaces. In addition to quality and productivity improvements, the separation of refining steps has led to savings in energy and raw materials.[184]

Beginning with casting, however, the number of processing steps has decreased (figure 3-13).

[183] Estimate based on discussions with industry executives, as reported by M. Schroeder, "Low Demand, Flat-rolled Profits," *Business Week*, January 1991, p. 76; [* * *].

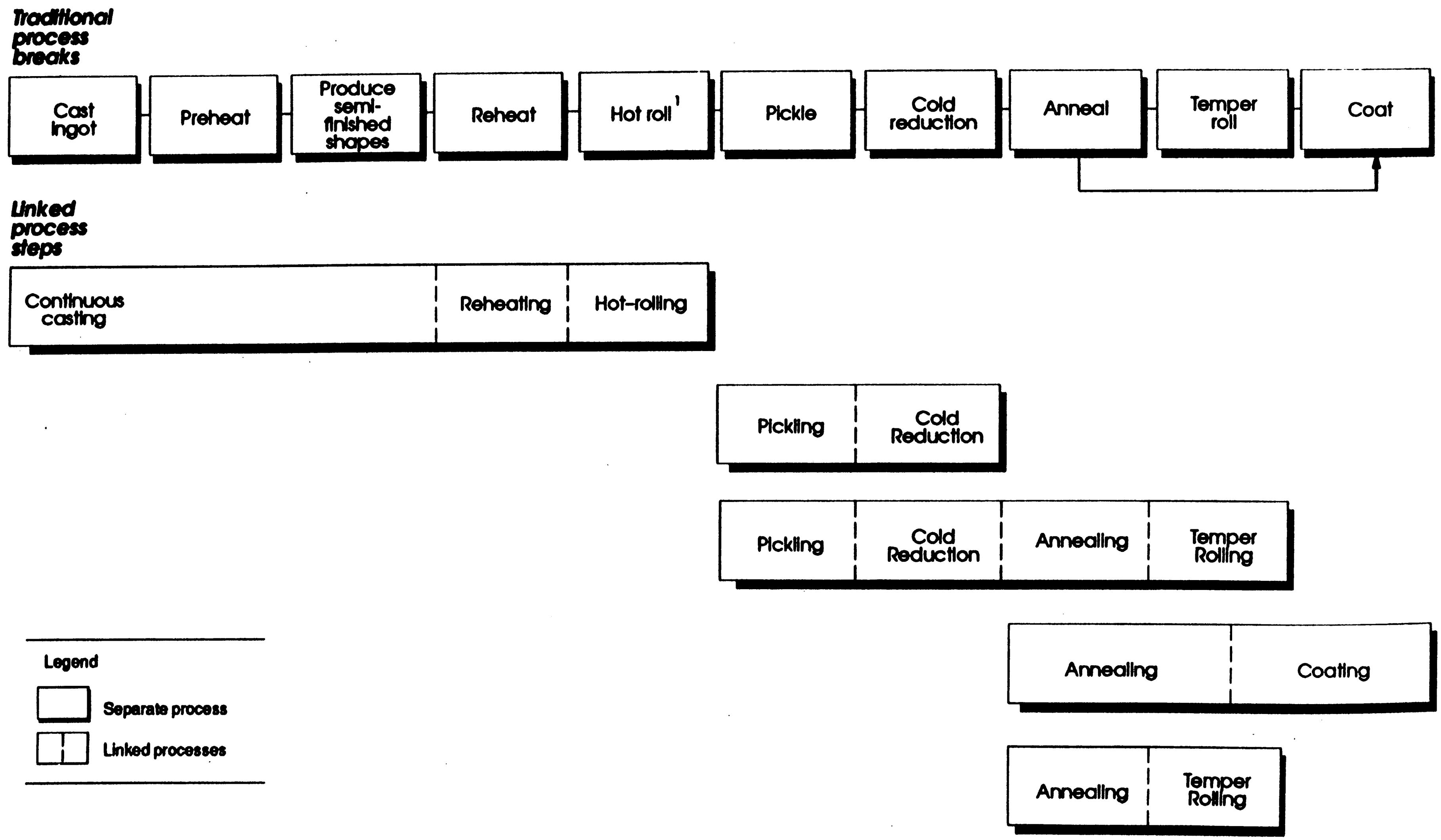
[184] Masami Sato, "Recent Trends in Technological Development in the Japanese Steel Industry," Washington D.C., Apr. 25, 1991.

Figure 3–12
Separation of the refining process



¹ Ladle metallurgy may encompass more than one step, such as reheating, degassing, inclusion control, and decarburization.

Figure 3-13
Increasing continuity in processing



[1] The production of many steel products ends with the hot rolling process.

Continuous casting consolidates several steps, and in several cases linkages have been formed between two or more formerly discrete steps. This trend of consolidating processes is now moving upstream to the ironmaking and steelmaking processes, as several technologies recently commercialized or under development seek a "one-step" process. Such technologies aim to replace coke ovens, blast furnaces, and in some cases, steelmaking furnaces, with a single reactor. Since most of these technologies are in an embryonic stage, accurate cost comparisons are difficult. However, the savings in capital costs for new installations of such technologies promise to be substantial.[185]

The movement toward more continuous processes is leading to better product quality and consistency, lower labor requirements, improved yields, reduced capital and operating costs, and shorter overall processing times.[186,187] Continuous operations resulting from coupling processes also makes production control somewhat easier, as operations run steadily.[188,189]

Continuous Casting

By eliminating process steps, continuous casting technology offers quality improvements and productivity-related cost advantages. With rare exceptions, continuous casting is essential to the long-term competitiveness of a firm. The U.S. industry has lagged behind most major competitors in the adoption of continuous casting (figure 3-14). However, the industry has made up ground in recent years, and current installation programs should raise the U.S. continuous cast ratio to over 80 percent by 1995.

Ladle Metallurgy

Ladle metallurgy as a final refining step provides further productivity benefits through higher utilization rates and improved operating practices for steelmaking furnaces and casters and higher quality steel.[190]

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[185] D. F. Barnett, "New Technologies for a New Century," presented at Steel Survival Strategies VI, New York, NY, June 19, 1991.

[186] Frank Fitzgerald, New York, NY, June 26, 1990.

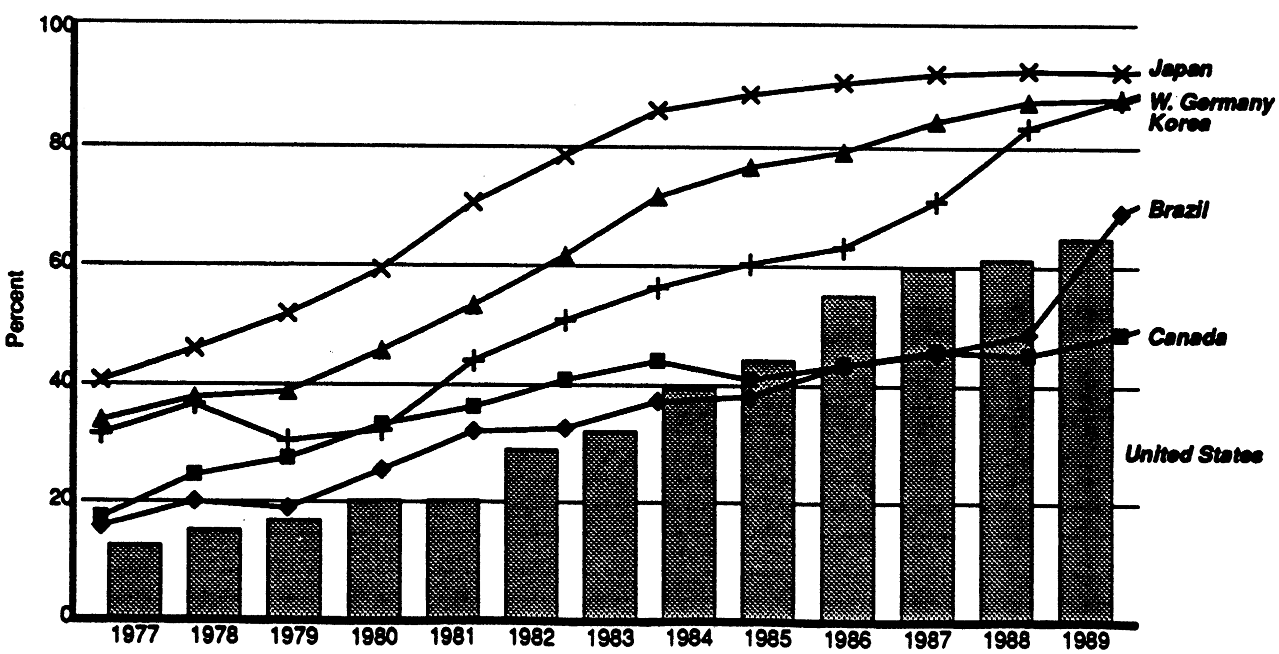
[187] "Inland Steel Industries Inc. and Nippon Steel Corp. to Proceed with Joint Venture Continuous Cold Mill," *Skillings Mining Review*, Apr. 18, 1987, p. 4-5.

[188] George McManus, "Process Controls: Steel Shapes Up," *Iron Age*, July 1988, p. 18.

[189] Process linkage does have drawbacks. The linkage of various melting, casting and rolling processes means that a breakdown in any one operation brings all coupled processes to a halt. This can prove to be expensive, as capacity utilization levels suffer and costs rise.

[190] William Hogan, "Ladle Metallurgy," *Iron and Steel Engineer*, November 1989, p. 39.

Figure 3-14
Continuously cast production as a share of total production, 1977-89: United States catching up to competitors



Source: International Iron and Steel Institute.

Adoption of ladle metallurgy facilities in the U.S. industry has occurred in two waves, the first during the 1960s and the second during the 1980s. (figure 3-15) The relative hiatus in adoption during the 1970s can be ascribed to a general underutilization of installed facilities. However, increased customer demands for higher quality steel and rising continuous casting rates revived investment in ladle metallurgy facilities in the late 1970s. Since then, the number of ladle metallurgy facilities in the U.S. has increased by over 150 percent.

The U.S. industry is generally on par with European, Japanese, Korean, and Canadian steelmakers, and better than most others, with respect to ladle metallurgy capabilities.[191] However, equipment suppliers report that U.S. orders have fallen off in the past year or so relative to orders from some other countries, notably Japan and Korea.

Process Linkage

Process linkage, or the combining of two or more separate processes, is becoming more widespread in the United States, especially among sheet producers in their rolling, treating, and finishing operations. The U.S. industry appears to compare favorably with its competitors in this area. The continuous cold mill complex probably represents state-of-the-art technology with respect to process coupling. Currently in operation only in Japan at Nippon Steel's Hirohata works and at the I/N TEK facility in Indiana, the concept links five historically separate process steps together (pickling, cold reduction, annealing, temper rolling, and inspection) with the aid of five mainframe computers. This facility allows a reduction in process time from twelve days to under one hour, with concurrent improvements in quality and cost.[192]

Another major application of process coupling is Nucor's flat-rolled plant in Crawfordsville, Indiana. With the exception of the plant's thin slab caster, there is really little new technology at the facility. However, linking state-of-the-art casting, temperature stabilization, and hot-rolling technology is a significant breakthrough, possible only because of extensive computer monitoring and controls. The plant's integrated monitoring and control system covers all stages of production, from scrap yard to hot strip mill.[193]

Computerization

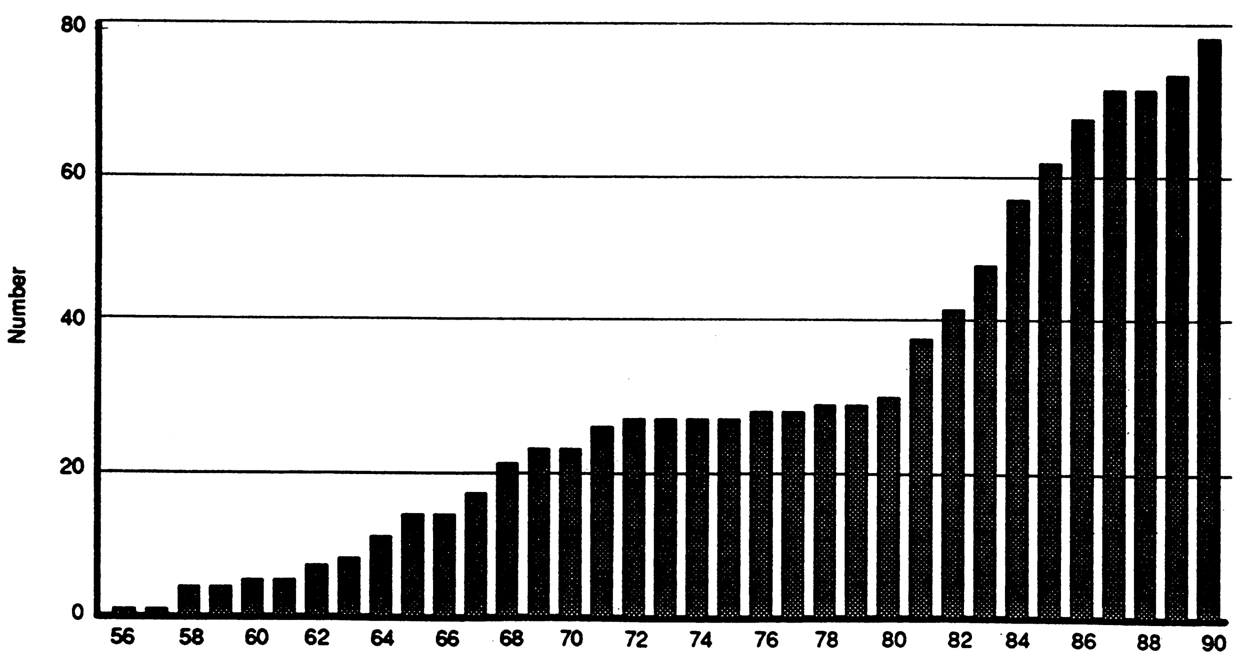
As indicated above, computerization has facilitated the linkage of process steps and transformation of such batch processes as annealing or coating into more continuous processes. However, digital monitoring and control systems have been applied to virtually all areas of the steelmaking process.

[191] Suppliers of ladle metallurgy equipment, discussions with USITC staff.

[192] J. R. Burger, "Indiana hosts Hirohata clone," *Metal Bulletin Monthly*, January 1990, p. 56.

[193] Wallace Huskonen, "Nucor Starts Up Thin-Slab Mill," *33 Metal Producing*, August 1989, p. 36.

Figure 3-15
Number of ladle metallurgy facilities installed in United States, 1956-90, cumulative: Rate of installation highest in 1960s and 1980s



Source: "U.S. Steel Industry Data Handbook 1989", 33 *Metal Producing*, May 1989.

The benefits of computer process control are many. Direct benefits of reduced labor and energy use and improvements in yield, productivity, and quality, are bolstered by indirect benefits of improvements in utilization of skilled personnel, maintenance planning, and flexibility with respect to raw material usage. Moreover, payback periods are typically brief.[194]

Improvements in the accuracy and reliability of sensors, processors, and software programs have contributed to incremental innovation at established facilities. Many of the early basic oxygen furnaces, electric furnaces, ladle metallurgy stations, continuous casters, and rolling mills were originally installed with basic analog control systems. Further improvements in monitoring and control, however, have served to improve even further the operation of the equipment.[195] The application of advanced computer-based (digital) systems for process control and continuous monitoring of equipment operation has been a major factor contributing to improved productivity and product quality in modern steel mills.[196]

Much of the domestic investment over the past few years, especially for rolling mills, has involved the replacement of analog electrical/mechanical control systems with faster and more accurate digital electronic/hydraulic systems. This has allowed the U.S. industry to substantially improve product quality without completely replacing facilities. Most U.S. producers of high quality sheet products have successfully adopted this technology during modernization programs over the past few years, closing the gap between their product and that of advanced competitors.[197]

U.S. steelmakers expenditures on automation, although substantial, apparently lag behind that of many of their international competitors. Automation expenditures for the U.S. steel industry are estimated to have averaged over $130 million annually between 1984 and 1988, or about 5 percent of total capital spending (approximately $1-2 per ton of raw steel produced). Suppliers of such equipment and software indicate that over the past year or two the domestic average has improved. In contrast, the international steel community has spent, on average, about 11 percent of capital investment on automation (or $3-4 per ton of production). Expenditures by individual industries and companies vary widely, with some industries reportedly investing an average of 20 percent of their capital on automation, control, and process optimization.[198]

Artificial intelligence (AI), the cutting edge of computer technology, is starting to be applied to the steelmaking process. AI is an area of computer processing that includes natural language processing, robotics, image and pattern recognition, and expert systems. Expert systems is the area of AI that is being applied most vigorously in the steel industry. Expert systems are computer programs capable of simulating the attributes and abilities of experts.[199] They represent a tool that affects three major areas: costs, processing time, and quality.[200] Work on expert systems, usually for diagnostic analysis (such as interpretation, forecasting, monitoring and control, trouble shooting and repair) is proceeding at steel companies and their equipment suppliers around the globe. A major advantage of expert systems is the ability to optimize and standardize operating practices and procedures.

Expert systems are being applied across the board in the production areas of the steel industry. A review of the literature indicates that the areas that have received the most work overseas seem to be the blast furnace and the continuous caster, although work on expert systems has involved all major process areas.[201]

Work on expert systems in the U.S. industry has lagged behind development work overseas. Scheduling applications of expert systems is the focus of domestic study, an area which has the potential for significant cost savings. The application of expert systems to production processes seems to have been pursued to a greater extent by foreign companies, most notably the Japanese.

Although only a few U.S. steelmakers are actively involved in developing expert systems, interest appears to be growing.[202] For example, the U.S. industry is jointly pursuing a development program that will use expert systems to combine sensing technology, process models, and process controls in a single intelligent processing system. On December 14, 1990, a research proposal was submitted to the U.S. Department of Energy by the domestic industry proposing a

[194] David H. Clark, "Computer Process Control in the Steel Industry," presented at the International Iron and Steel Meeting, Toronto, Canada, October 1981.

[195] Ibid. Data collected in 1980 indicated that 50 to 85 percent of the computer installations in the global steel industry were for retro-fit applications.

[196] D. Springorum and A. Born, "Use and application of 'Artificial Intelligence' (AI) and expert systems in the German steel industry," *Use and Application of Expert Systems and Artificial Intelligence*, International Iron and Steel Institute, Committee on Technology, April 1989.

[197] See "Actions to Improve Product Quality and Customer Service," USITC, *Steel Industry Annual Report*, USITC publication 2316.

[198] David L. Schroeder, quoted in W. Huskonen, "Opportunities in EAF Automation," *33 Metal Producing*, November 1990, p. 25.

[199] A. Born, "The application of expert systems," *Use and Application of Expert Systems and Artificial Intelligence*, International Iron and Steel Institute, Committee on Technology, April 1989.

[200] William A. Tony, "Nothing Artificial About Impact of Expert Systems on North American Steel Industry," *Iron and Steel Maker*, January 1991, p. 18.

[201] K. Noderer, and H. Henein, "A Survey of the Use of Expert Systems in the Iron and Steel Industry," *Ironmaking Conference Proceedings*, Iron and Steel Society/AIME, vol. 49, 1990.

[202] Rex Maus, President, cited in R. Harvey, "U.S. Steelmakers Get Smart About Intelligent Processing," *Iron Age*, July 1990, p. 27.

$24.6-million, five-year project to pursue this program. The proposal includes 10 sensor and four modeling and control projects. If these projects are successful, estimates of the savings to the domestic industry run to approximately $500 million annually, about 1 percent of sales annually.[203]

Convergence of Technology

Competition between the two routes of steelmaking has led to a cross adoption of process elements which has narrowed the differences in the process routes.

Small scale technology, such as electric arc furnaces and direct reduction facilities, are increasing in size, leading to "mini" mills that produce close to, or over 1 million tons annually. Moreover, the product line distinctions between minimills and integrated mills are diminishing as minimills begin to produce flat rolled and heavy structural products that were once produced virtually exclusively by the integrated mills.

As minimills move into these higher quality products, scrap quality is becoming a limiting factor. One response has been for minimills to incorporate iron ore based ferrous inputs in their steelmaking process. Minimills are making increased use of direct reduced iron as a major raw material and, at a minimill in Brazil, molten iron from a blast furnace is being fed into electric arc furnaces.

Nonintegrated producers are also applying integrated techniques to melt scrap. The energy-optimizing furnace, a small scale steelmaking furnace using oxygen and fossil fuel, has been adopted by minimills in Brazil and the United States. Oxygen blowing and other basic oxygen process technology has been applied to electric arc furnaces, leading to an improvement in their refining capabilities.[204]

Integrated producers are increasingly applying electric arc furnace principles in their steelmaking operations either at primary steelmaking facilities, usually for the production of bar products, or at electric ladle reheating stations, where batches of steel from BOFs is fine tuned.

Integrated producers are also adopting methods that allow greater use of scrap in their BOFs than has previously been possible. Producers in both groups are increasing their reliance on secondary refining in the ladle.

The high levels of competition that now typify the global steel industry should continue to add impetus to the cross-adaptation of successful practices between the two routes. While it is unlikely that a complete convergence of the processes will occur, the capital cost savings of smaller scale production are formidable. The steel industry of the future, while still diverse, is likely to contain fewer large facilities and more smaller ones. Some integrated producers have indicated that it is only a matter of time before they move to smaller scale production technology (thin slab casting),[205] and it is likely that the leading integrated steel companies of the next century will depend on small-scale, capital-saving technologies of the kind now associated with minimills.[206]

Outlook

The continuing development of steelmaking technology and the associated changes in the way steel is produced will have beneficial effects for steelmakers around the globe. However, some changes may offer greater relative benefits to U.S. producers. One example is the labor-saving nature of technological advancement, due to increasing computerization and fewer process discontinuities. Since labor rates in the United States for steelworkers are relatively high compared to other countries, this should again favor U.S. producers. Another example is the lower capital investment requirements (per ton) for nonintegrated capacity. Since the United States has historically had a high cost of capital,[207] this trend should reduce that disadvantage.

Whether because of high borrowing costs or other reasons, the rate of capital investment in the U.S. industry has been lower than Japanese and European producers in recent years. For the period 1985-1989, annual capital investment by the Japanese and European[208] industries averaged approximately $37 per metric ton and $29 per metric ton, respectively.[209] During the same 5-year period, annual capital expenditures of the U.S. industry averaged $24-25 per metric ton.[210] While comparisons are difficult due to changing exchange rates, industry coverage,[211] modernization strategies, and the structure of the industry,[212] they still indicate that the U.S. industry may be falling further behind major competitors in some areas.

The outlook varies somewhat with respect to the various industry segments. Virtually all the major integrated producers have staked their future on high

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[203] Tony, "Nothing Artificial," p. 21.

[204] George McManus, "Electric Furnaces: A Hotbed of Changes," *Iron Age*, June 1989, p. 37.

[205] Francis Mer, quoted in "Usinor president blasts VRAs," *American Metal Market*, June 20, 1991, p. 4.

[206] Marcel Genet, "How to be competitive in steel in the 1990's," Proceedings of Metal Bulletin's 3rd European Steel Conference, Munich, Oct. 30, 1989.

[207] R. McCauley and S. Zimmer, "Explaining International Differences in the Cost of Capital," *Federal Reserve Bank of New York Quarterly Review*, Summer 1989.

[208] Data includes 9 European countries; Belgium, France, West Germany, Italy, Luxembourg, Netherlands, Portugal, Spain, and the United Kingdom.

[209] Based on capital expenditure and production data of the International Iron and Steel Institute.

[210] Based on data collected by the U.S. International Trade Commission.

[211] IISI data indicated annual U.S. expenditures to average $19 per metric ton; they are believed to understate expenditures, due to incomplete coverage of the U.S. industry.

[212] The U.S. industry has a relatively large minimill sector. As noted before, modernization and construction costs for minimills are significantly less than for integrated mills.

quality, high value-added sheet products. In order to participate in this market, all producers are in the midst of spending hundreds of millions of dollars on improving production technology. Whether the market can accommodate all of them, and whether customers can be convinced to pay prices that will make the investment profitable remains to be seen.

Smaller integrated producers are being affected by the entry of minimills into the commercial sheet market and by the desire of customers for improved quality even in commercial grade products. Many of these producers acquired their facilities as they were spun off from major firms, often at relatively low prices. A major factor in the competitiveness of this group has been low financial costs. Although modernization will raise those costs, producers that fail to modernize their facilities may find their customer base shrinking and their costs becoming less competitive as the number of sheet minimills increases.

The increasing ability to produce higher value products in smaller production increments indicates the possibility of further growth in the minimill sector, although overcapacity in traditional product lines may lead to a consolidation of certain facilities. Growth in this sector may, however, be limited to a handful of larger minimill firms as investment costs for small scale production of sheets, for example, are much greater than for more traditional minimill products. If thin slab casting technology is able to overcome its current quality problems, it will pose a growing competitive challenge to major integrated firms specializing in high performance cold-rolled and coated steel sheet.

Exchange Rates

Industries which compete with foreign producers in any market or rely on imported components in production can be significantly influenced by exchange rate movements. The extent of this influence depends in large part on the frequency and magnitude of changes in the exchange rate. During the 1980s, variability was significant, as the real value of the dollar fluctuated dramatically against the currencies of other major steel-producing countries.[213]

Changes in exchange rates determine relative cost and price position, complicate efforts to make cross-country comparisons, and confound efforts to label unfair trade practices. The purpose of this discussion is to assess the effects of shifts in real exchange rates on the cost competitiveness of U.S. steel producers, and the related effects on domestic steel production and trade. In addition, effects on investment decisions and other issues related to currency fluctuations are examined. This discussion begins with a generalized discussion of exchange rate effects, reviews principal findings, and concludes with a more detailed examination of the effects of exchange rate movement based on statistical analysis and discussions with industry executives.

General Effects of Currency Fluctuation

Exchange rate variability has a number of effects. As currencies appreciate, export prices increase in foreign currency terms, lessening the international competitiveness of a country's exports. Similarly, import prices are likely to decline in home currency terms in response to a currency's appreciation. In both cases the magnitude of change may depend on incentives and competition in domestic and foreign markets. While appreciation reduces the demand in the country's own market for domestically-produced items as consumers substitute relatively cheaper foreign goods, it is likely to lower costs for industries which use imported products. Changes in industry shipments and on expected investment returns are likely to depend on the relative magnitude of these demand and cost-based effects.

Exchange rate fluctuations are also likely to affect investment decisions; to the extent that sustained real appreciation of the dollar makes facilities located in the United States less competitive in world markets, firms may be more likely to close these facilities.[214] Moreover, effects on import, export, and domestic prices will depend in part on expectations regarding the permanence of exchange rate movements: business response to temporary changes in currency values is unlikely. In addition, market conditions and the market and cost structure of a domestic industry are likely to influence its response to international shocks of any kind, including exchange rate fluctuations.[215]

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[213] It is important to analyze exchange rate movement in real terms. Changes in real exchange rates are measured by changes in relative purchasing power of the dollar vis-a-vis other currencies, or by adjusting changes in the external value of the dollar (the nominal exchange rate) by relative inflation rates in the U.S. and abroad. For example, if the nominal value of the dollar was to increase from 100 Yen to 200 Yen, but at the same time all prices in Japan (in Yen terms) were to double, there would be no change in the relative competitiveness of U.S. exports or import-competing domestic shipments versus those of Japanese producers; similarly, costs in dollar terms of inputs imported from Japan would be unchanged. It is movement in the real (or inflation-adjusted) value of a currency that determines the ability of producers to compete internationally.

[214] This tendency will be moderated by the high sunk costs which may be associated with offshore production, suggesting that only when the dollar is expected to appreciate for the long-term (or to remain at its currently high value) will there be strong incentives for shifting production to foreign sites. There has been much discussion of this issue in the professional economics literature in the past few years; see, for example, Robert Baldwin, "Hysteresis in Import Prices: The Beachhead Effect," *American Economic Review*, vol. 78 (September 1988), pp. 773-85.

[215] For discussion of these issues, treated in more detail below, see Rudiger Dornbusch, "Exchange Rates and Prices," *American Economic Review*, vol. 77 (March 1987), pp. 93-106; Robert Feinberg, "The Effects of Foreign Exchange Movements on U.S. Domestic Prices," *Review of*

Discussion of Findings

From 1980 to 1989, nominal exchange rates fluctuated widely, with the U.S. dollar reaching a high of almost ¥263 and 3.47 Dm in the early 1980s, before dropping to a low of ¥121 and 1.58 Dm later in the decade. These changes in the value of the dollar did not appear to reflect different inflation rates among the countries (i.e., the change in the nominal value of the dollar approximated the change in the real value of the dollar). Such shifts had a significant effect on the relative cost competitiveness of U.S. producers.

In turn, such cost effects appear to have contributed to shifts in the pattern of steel trade. Results of a statistical analysis of U.S. trade data, for example, indicate that U.S. import prices and volumes were affected significantly by exchange rate changes. The relationship between exchange rates and export prices and volumes, on the other hand, was less clear. Domestic shipment volumes and prices, as well as investment strategy, did not appear to be influenced in any systematic manner by exchange rate movements (except to the extent that changes in imports affect market share).

[215] *—Continued*
Economics and Statistics, vol. 71 (August 1989), pp. 505-511; and Morris Goldstein and M.S. Khan, "Income and Price Effects in Foreign Trade," ch. 20 in Jones and Kenen, eds., *Handbook of International Economics* (Amsterdam: North-Holland, 1985), pp. 1041-1105.

The following is a more complete discussion of the effects of exchange rate variability on the steel industry.

Effects on the Steel Industry

Costs

The effect of exchange rate changes on relative costs greatly complicates assessment of relative competitive positions among countries. There are readily available examples of exchange rate changes significantly affecting relative costs. In November 1990, for example, the U.S. steel industry's cost advantage over German producers was about $79 per metric ton for cold-rolled sheet (see chapter 4, table 4-3). By June 1991, however, a 16-percent appreciation of the dollar against the German mark had eroded this margin and production costs were roughly equal.[216]

Figure 3-16 provides an example of how an appreciation of the dollar from 2 to 4 foreign currency units can affect such costs. In this example, labor costs and certain other costs remain constant in foreign currency units, but fall by 50 percent in terms of dollars.

Not all costs, however, fall this dramatically. In the steel industry, many internationally traded raw materials are dollar-denominated; as a result, they are

[216] World Steel Dynamics, Steel Survival Strategies Conference, New York, June 1991.

Figure 3-16
Effects of dollar appreciation on a foreign steel producer's production costs (an example): Home costs rise while dollar costs fall

	Period 1 2 HCU[1] = $1.00		Period 2 4 HCU = $1.00	
	HCU cost	*$ equivalent*	*HCU cost*	*$ equivalent*
Labor	320 HCU	$160	320 HCU	$80
Materials				
HCU denominated	240	$120	240	$60
$ denominated	360	$180	720	$180
Total materials	600	$300	960	$200
Other	80	$40	80	$20
Total production costs	1000 HCU	$500	1360 HCU	$340
% change	---	---	+36%	(32%)

[1] HCU = Home currency unit

not directly affected by appreciation, at least in terms of dollars, mitigating the effect of exchange rate changes on relative costs. Available data suggest up to one-third of foreign steelmaking costs for integrated producers are dollar-denominated.[217]

Pricing

Changes in relative costs due to exchange rate fluctuations also affect relative prices among countries; in response, production and trade patterns adjust. The extent to which adjustment occurs depends on a number of factors.

Competitive responses by firms is one of such factors. Because firms with some price-setting power may be able to vary profit margins without incurring major losses, they may, in part, offset the effect of exchange rate movements on home currency prices. Interviews with steel industry executives and statistical analysis tended to confirm such behavior.[218] This type of strategy appears to be more applicable with respect to spot-market or discretionary sales than to longer-term contract sales, which reportedly account for an increasing number of domestic imports.[219]

In the case of long-term contracts, producers and customers may work together to offset effects of exchange rate changes. In one case, a steel producer stabilized prices on specific products to provide a "floor" during periods of unfavorable exchange rates, but compensatory profits during more profitable periods; the types of products which would be amenable to such a strategy were negotiated with the customer, who was interested in ensuring supply continuity.[220]

Perceptions regarding long-term trends in exchange rates also contribute to price rigidity. Producers may be less willing to adjust prices if a shift is perceived as only temporary.

The degree to which producers can effectively implement pricing strategies depends largely on the substitutability of their product; the more products are differentiated in terms of quality or service, the greater control producers can exercise over prices. Recognizing this, some foreign producers have reportedly targeted narrowly defined product areas as a strategic response to the vagaries of exchange rate movements.[221]

Trade

Through price effects, exchange rate movements may also alter the volume of steel imports and exports. Discussions with European and Japanese steel industry executives suggest that, as with prices, increased product differentiation and producer-customer relations have reduced the sensitivity of trade to exchange rate volatility. Many products remain more price-sensitive, however, and discussions with domestic and foreign industry officials suggest that trade flows in these products will continue to be significantly influenced by movements in relative prices worldwide.[222]

In the United States, it appears that export levels continue to be influenced by exchange rate movements. Discussions with executives from U.S. firms suggest that export strategy is directly tied to the value of the dollar, as evidenced by increased export levels during 1987-89. During this time, a weaker U.S. dollar and strong markets in Asia resulted in relatively higher prices abroad and contributed significantly to major increases in U.S. exports to China, Japan, and Korea.

Statistical Analysis

A statistical examination was performed to analyze the effect of exchange rate changes on prices and volumes of U.S. shipments, exports, and imports.[223] This analysis was performed on three products: hot-rolled carbon steel sheet, widely used in construction and in automotive applications; cold-rolled carbon steel sheet, widely used in machinery and equipment; and carbon steel wire rod, widely used in construction. While the first two products are produced almost exclusively by integrated producers, wire rod is produced mainly by minimills.

The results indicate that during 1980-89:[224]

- Domestic shipment volumes and prices do not appear to have been influenced by exchange rate movements;
- Both import volumes and prices were affected by exchange rate changes on a delayed (or lagged) basis; and
- Export volumes, but not prices, were apparently affected by real appreciation of the dollar.

The findings regarding domestic shipments are consistent with expectations. As shown in the tables

[217] PaineWebber, *Cost Monitor #13*, Jan. 11, 1991, p. 3.

[218] Catherine Mann, "Prices, Profit Margins, and Exchange Rates", *Federal Reserve Bulletin*, vol. 72 (June 1986), pp. 366-379.

[219] Discussions with European and U.S. steel producers indicated that as much as 70 percent and 40 percent, respectively, of total sales are to long-term customers.

[220] European industry officials, interviews with USITC staff, April 1991.

[221] Maki Kanekawa, "Currency Fluctuations and Corporate Strategies", *Japan Almanac, 1990*, p. 82 and European steel producers, discussions with USITC staff, April 1991.

[222] U.S. and European industry officials, interviews with USITC staff, December 1990-April 1991.

[223] See appendix G for a discussion of the methodology employed and results.

[224] An important cautionary note in interpreting all the results is that the exchange rate effects identified are direct effects on volumes and prices. Not considered explicitly are exchange rate effects which, through their effects on downstream demand or cost, influence the volumes and prices of steel. These indirect cost effects are believed to be small. However, to the extent that automobile or construction demand is affected by exchange rate movements, steel prices and shipments will also be indirectly affected.

below, domestic firms do not appear to have adjusted prices and volumes of domestic shipments significantly in response to exchange rate shifts. Table 3-11 shows that for each 1 percent appreciation in the value of the dollar, the effect on domestic prices varied from no response to an increase of 0.09 percent.[225] Volume changes were larger, but not statistically significant.

The second finding is also generally consistent with expectations. The effect of exchange rate change appears to have been more pronounced on the volume of steel imported than on prices for all three products (table 3-12), although the estimated volume change for hot-rolled sheet was not statistically significant. With respect to the timing of the effect, results suggest that the bulk of exchange rate effects may not occur for three to four quarters. This is not surprising given the lead time required to order, produce, and ship steel; in addition, the compilation of trade statistics also results in certain reporting lags.

The third finding, that export volumes, but not prices, are affected by exchange rates, is consistent with interviews which suggest that export pricing is primarily based on foreign steel consumption levels and domestic costs, whereas export volumes are more directly affected by real exchange rate movement. In addition, statistical results may be affected by changes in product mix. The depreciation of the dollar in the latter part of the 1980s, for example, permitted U.S. producers to compete in lower value, commodity-grade items, which could have resulted in an apparent decline in real prices.

As shown in table 3-13, a one-percent appreciation in the value of the dollar would appear to elicit an estimated 1-7 percent decline in export volumes. The curious effect of exchange rate movements on wire rod prices could reflect changes in product mix.

Outlook

Movements in real exchange rates will continue to affect the cost competitiveness of steel producers and, in turn, production and trade flows; the extent of these effects will depend on the magnitude and frequency of such changes. However, increased production flexibility could diminish these effects as producers increase specialization in specific products, cultivate long-term customer relationships, and the industry is increasingly globalized. As this analysis indicates, exchange rate changes can affect the volume and direction of steel trade. Steel traders (i.e., companies that import and export) have expressed a particular interest in currencies that are significantly overvalued. They note that full pass through of exchange rate changes in such instances could price their products out of foreign markets. On the other hand, not adjusting prices to reflect exchange rate changes increases the likelihood of dumping complaints.[226]

Table 3-11
Estimated effects of a one-percent dollar appreciation on prices and volumes of domestic shipments of hot-rolled sheet, cold-rolled sheet, and wire rod, 1980-89

Product	*Estimated percentage change*	
	Prices	*Volumes*
Carbon steel:		
Hot-rolled sheet	0.07	-0.12
Cold-rolled sheet	0.09	-0.13
Wire rod	0.00	-0.48

Table 3-12
Estimated effects of a one-percent dollar appreciation on prices and volumes of imports of hot-rolled sheet, cold-rolled sheet, and wire rod, 1980-89

Product	*Estimated percentage change*	
	Prices	*Volumes*
Carbon steel:		
Hot-rolled sheet	-.78	.67
Cold-rolled sheet	-.36	1.14
Wire rod	-.28	.63

Table 3-13
Estimated effects of a one-percent dollar appreciation on prices and volumes of exports of hot-rolled sheet, cold-rolled sheet, and wire rod, 1980-89

Product	*Estimated percentage change*	
	Prices	*Volumes*
Carbon steel:		
Hot-rolled sheet	0.22	-2.62
Cold-rolled sheet	0.52	-1.65
Wire rod	-1.00	-6.56

[225] Since dollar appreciation lowers the dollar cost of imports, it should create downward pressures on domestic prices. The statistical results for hot and cold rolled sheet, which indicated small positive effects, were therefore unexpected.

[226] American Institute for International Steel, Inc., Press Release, Mar. 15, 1991.

CHAPTER 4
INTERNATIONAL COMPETITIVE ASSESSMENT

The ability of producers to compete successfully in the market depends on their ability to satisfy customer needs; in the case of steel, as with most industries, these needs include performance with respect to price competitiveness, product quality, and the nature of services provided to support sales. Although other factors, such as government policy and consumer buying strategies, may ultimately affect sourcing decisions, these three factors are crucial to most consuming industries. The purpose of this chapter is to examine (1) the relative importance of price, quality, and service in determining firm competitiveness in steel; (2) the evolving competitiveness of the U.S. industry in these areas; and (3) the outlook for the industry.

Discussion of Findings

Information gathered through research, fieldwork, and questionnaires indicates that, in terms of price, quality, and service, the U.S. steel industry is significantly more competitive today than it was in the early- and mid-1980s, particularly in its home market. Prices offered by U.S. producers are no longer significantly higher than those offered by importers.

With respect to quality and service, the U.S. industry has taken a number of steps to improve its performance since 1985. In this period, domestic consumers have observed improvements, some of which have been significant. The extent of current overall customer satisfaction, however, varies among consumer groups, with generally higher levels of satisfaction reported by the automotive industry and lower levels by the metal cans/containers industry (despite recent quality improvements noted by this industry segment).

Nature Of Competition in the Steel Industry

Steel companies compete for markets on the basis of price, quality, and service (figure 4-1). Price consists of a base price, charges for "extras" (e.g. high gauge uniformity), and any discounts. Product quality is the combination of attributes that make a steel product fit for further processing and ensure that the final product performs in operation. Service is defined as performance with regard to delivery, assistance provided to customers, and financing terms offered.

The relative importance of these three elements varies among consumers. In certain applications, the quality of steel, in terms of formability or finish, for example, is not critical. This is particularly true for many construction applications. For automotive and household appliance manufacturers, on the other hand, drawing characteristics and finish are critical, and users are often willing to pay a premium when they determine that the price differential is worth the benefits of higher quality.[1] Service appears to be an increasingly important purchasing criterion. More customers demand just-in-time delivery, electronic data interchanges, and collaboration with steel suppliers in the design stage of product development.

To assess the relative importance of price, quality, and service in purchasing decisions, the Commission included questions about sourcing decisions in its 1991 questionnaire sent to steel consumers. Those who increased their share of either foreign or domestic purchases between 1985 and 1990 were requested

[1] Executives from various steel companies, interviews by USITC staff, Los Angeles, Detroit, and Cleveland, December 1990 and May 1991.

Figure 4-1
Factors of competition in the steel industry

Price	Quality	Service
• Mill price (base price plus charges for "extras" less any discounts) • Delivery and other charges	• Internal quality (chemistry, microstructure, grain size, inclusions) • Dimensional quality (shape, size, straightness) • Surface quality (seam, smoothness, shearing) • Properties (tensile strength, ductility, hardness, wear and corrosion resistance, weldability) • Presentation (packaging, marking) • Coating quality (type of coating, thickness uniformity, weight)	• Reliability of delivery • Pre-sale technical assistance (in design stage of manufacturing) • Post-sale technical assistance • Responsiveness to complaints • Delivery flexability/availability of just-in-time delivery • Financial terms (credit terms and availability)

to assess the degree of importance of each of the three factors in influencing their decision to shift sources; those who increased their use of domestic steel were also requested to evaluate the relative importance of import restrictions on their decision.[2] As shown in table 4-1, price, quality, and service were each deemed to be of "principal" importance by a majority of those surveyed, with one exception. Among purchasers who expanded the share of purchases from foreign suppliers during the period, only one quarter cited service as a principal factor in their sourcing decision. This appears to indicate that delivery times, which are generally longer from overseas sources, were not as critical to their operations. On the other hand, most respondents considered import restrictions to have been relatively unimportant in the increased use of domestic steel.

The relative importance of each of the factors influencing purchasing decisions varies somewhat from one consuming group to another, as shown in table 4-2.[3] Price was viewed as being of principal importance in increasing domestic purchases by the majority of respondents in all consuming groups except the nonelectrical machinery and equipment industry. Service was rated as principally important by the majority of purchasers in all consuming groups except processors. Quality was rated as principally important by the majority of purchasers in all sectors but two: fabricated structural metal products and service centers.

[2] The number of companies indicating increased domestic purchases (83-89, depending on the product) was almost double the number reporting increased purchases of foreign steel (44-46).

[3] Data shown in table 4-2 reflect the opinions of only those respondents who reported an increase in their share of domestic purchases during 1985-90. Questionnaire responses from purchasers who increased their share of foreign purchases during the period were not sufficient to provide a valid comparison.

The variation in weight that steel-consuming industries ascribe to price, quality, and service has an important consequence. A company that cannot compete effectively in terms of price (because of relatively high costs) can still be successful if it finds consumers that are willing to pay higher prices for its higher performance products and/or more efficient service. Alternatively, a producer that is not competitive in terms of quality and service can still be successful if it finds markets for which price is the principal purchasing criterion.

These sorts of distinctions do not appear to have been as important ten or twenty years ago, when steel was more commonly produced as a homogeneous commodity. Producers currently work more closely with their key customers, tailoring their output to meet specific needs. Certain high-value products, such as coated sheets for automotive use, are jointly developed by steel producers and their automotive clients for specific applications. Moreover, auto firms do not purchase steel in as uniform grades as they did previously; instead, specific types of steel products with unique characteristics are purchased for the various parts of the automobile, such as the hood and fenders.[4]

Many factors influence a firm's ability to be competitive in terms of price, quality, and service (figure 4-2). In terms of product quality, for example, competitiveness depends on the technology employed and the quality of the raw material inputs. It also depends on the workforce and the quality assurance program it implements. Excellence in service depends not only on technology and the quality of the workforce, but also on location, since a plant located

[4] Executives from various steel companies, interviews by USITC staff, Detroit and New York, May 1991.

Table 4-1
Importance of price, quality, service, and import restraints in influencing domestic and foreign sourcing decisions between 1985 and 1990, by consuming group

Factor	Consumers increasing share of domestic purchases during 1985-90: Principal importance[1]	Secondary importance[2]	Not particularly important[3]	Consumers increasing share of foreign purchases during 1985-90: Principal importance[1]	Secondary importance[2]	Not particularly important[3]
	Percent of respondents					
Price	76	23	1	63	24	13
Quality	64	24	12	71	20	9
Service	65	30	5	25	52	23
Import restraints	11	25	64	([4])	([4])	([4])

[1] "Principal importance" was defined in the questionnaire as a factor that is one of the most significant reasons underlying adjustments in the mix of domestic and foreign steel purchases.
[2] "Secondary importance" was defined in the questionnaire as a factor that is a secondary reason underlying adjustments in the mix of domestic and foreign steel purchases.
[3] "Not particularly important" was defined in the questionnaire as a factor that is not regarded as a significant reason underlying adjustments in the mix of domestic and foreign steel purchases.
[4] Not applicable.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 4-2
Importance of price, quality, and service in influencing sourcing decisions of purchasers who increased their share of domestic purchases between 1985 and 1990, by consuming group[1]

Consuming group/ factor	*Principal importance[2]*	*Secondary importance[3]*	*Not particularly important[4]*	*Number of respondents*
	Percent			
Metal cans/containers:				
Price	80	20	0	5
Quality	100	0	0	4
Service	50	50	0	4
Import restrictions	20	40	20	5
Fabricated structural metal products:				
Price	67	33	0	6
Quality	33	17	50	6
Service	67	17	17	6
Import restrictions	17	33	50	6
Nonelectrical machinery and equipment:				
Price	40	60	0	15
Quality	67	33	0	15
Service	87	13	0	15
Import restrictions	14	7	79	14
Electrical equipment:				
Price	83	17	0	6
Quality	100	0	0	5
Service	67	33	0	6
Import restrictions	0	0	100	4
Automobiles:				
Price	86	14	0	14
Quality	77	23	0	13
Service	85	15	0	13
Import restrictions	0	23	77	13
Other transportation:				
Price	100	0	0	5
Quality	100	0	0	5
Service	80	20	0	5
Import restrictions	0	40	60	5
Service centers:				
Price	100	0	0	7
Quality	29	57	14	7
Service	71	29	0	7
Import restrictions	14	14	71	7
Processors:				
Price	81	15	4	27
Quality	52	41	7	27
Service	48	41	11	27
Import restrictions	12	35	54	27

[1] The categories metal forgings/stampings and appliances had less than four responses, and are therefore excluded in this table.
[2] "Principal importance" was defined in the questionnaire as a factor that is one of the most significant reasons underlying increased use of domestic steel.
[3] "Secondary importance" was defined in the questionnaire as a factor that is a secondary reason underlying increased use of domestic steel.
[4] "Not particularly important" was defined in the questionnaire as a factor that is not regarded as a significant reason underlying increased use of domestic steel.

Note.—Totals may not add to 100 percent because of rounding.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Figure 4-2
Factors affecting price, quality, and service

Price	*Quality*	*Service*
• Level of competition (perfect competition, oligopoly etc.) • Relative costs • Market conditions • Business strategy • Nature of competition	• Technology[1] • Labor force quality[2] • Quality of raw material inputs • Effectiveness of quality assurance procedures	• Technology[1] • Labor force quality[2] • Location of plant relative to customers • Availability and quality

[1] Includes the sophistication of equipment/processes, conditions of equipment, and extent of application.
[2] Includes workforce skill level, morale, and effectiveness (individual as well as group).

near its consumers generally has a decided advantage over more distant plants. And particularly for customers that use high performance steel, superior customer service also requires pre- and post-sale technical support to the consumer. The ability to compete in terms of price depends on a variety of factors, the most important of which in the long term is relative costs, as discussed below.

Assessment of Key Elements

Price

For U.S. steel producers, price competitiveness is defined as the ability of U.S. steel firms to compete on the basis of price with foreign steel firms. On this basis, fieldwork and survey data suggest that U.S. steel companies are generally more competitive today than they were in the mid-1980s, particularly in the U.S. market. That is, prices offered by U.S. steel producers are no longer significantly higher than prices offered by foreign companies selling in the United States.

In a survey published by the Steel Service Center Institute, most service centers reported that prices offered by foreign producers were approximately the same as those offered by U.S. producers during 1990. This contrasts with the results of the same survey taken in the 1984-85 period, in which most service centers reported that prices offered for imported steel were 6-10 percent below domestic prices.[5] Furthermore, in the Commission's survey, more than three quarters of those steel purchasers who increased their share of domestic purchases during 1985-90 cited price as a primary factor (table 4-1).

Factors Affecting Price Competition

The prices offered by domestic steel companies depend in part on their business strategies. Those companies that place a higher priority on market share than profits are more likely to offer lower prices to increase sales. However, the ability to pursue a particular strategy is influenced by a number of factors. In the long run, the ability of U.S. steel companies to compete on the basis of price depends on their costs relative to those of their foreign competitors. It also depends on the industry structure (i.e. perfect competition, oligopoly), which determines the extent to which firms can influence price.

In the short run, market conditions are particularly important. During periods of tight supply, when companies are operating at relatively high rates of capacity utilization, producers are likely to exercise a degree of restraint in raising prices for customers with whom they have a long term relationships. Steel sold on the spot market to buyers with no established links to steel producers, on the other hand, tends to sell at premium prices. In such markets, prices for imported products can command prices that are higher than domestically produced material. Discussions with sources in Japan indicate that price premiums were in fact being paid for imported steel in that country during 1989, when the Japanese steel industry was operating at close to full capacity.[6] During the same period, premiums for imported steel were also reported by a relatively large number of U.S. steel service centers.[7]

In weak markets, however, when demand in consuming industries is falling, the nature of price competition can change significantly. As demand for steel is relatively price inelastic,[8] downward shifts in

[5] Steel Service Center Institute, *Business Conditions-Part I* (June 7, 1991), p. 3, and (December 4, 1986), p. 3.

[6] Representatives of the Japanese steel industry, USITC staff interviews, Tokyo, Japan, October 1989.

[7] Steel Service Center Institute, *Business Conditions-Part I* (November 3, 1989), p. 3.

[8] Steel consumption in any given period is not significantly influenced by price movements, as steel generally accounts for a small portion of the total cost of the merchandise in which it is ultimately incorporated. One of the largest markets for steel, for example, is the automobile industry. The roughly 1,600 pounds of steel that are used to produce a car have a value of approximately $500-600, which represents a relatively small portion of the total value of the finished automobile.

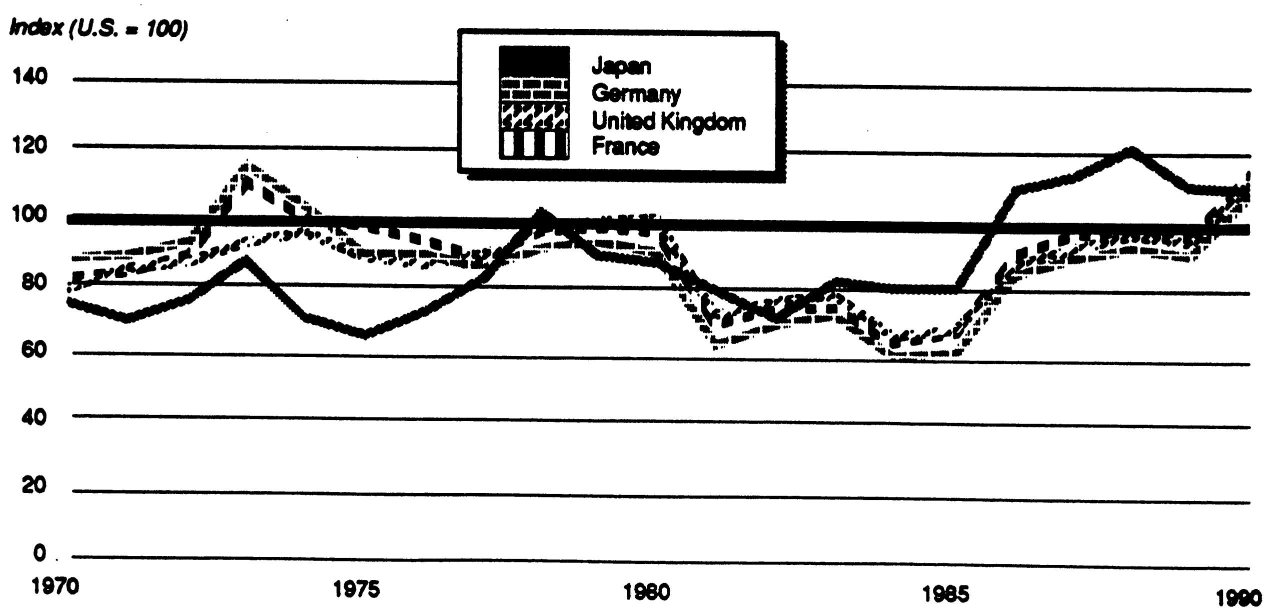
demand lead to pressures to reduce prices. In such instances, producers often attempt to resist these pressures by limiting production volume. The nature of the production process and the relatively high level of fixed costs associated with steelmaking, however, make it difficult to reduce production, particularly at integrated steel mills. A decision to close a blast furnace, for example, is an expensive one since costs associated with restarting it are considerable. Moreover, broader social and economic goals have often dictated that steelmakers maintain production in many countries in order to preserve employment.

As a result, production during market downturns has often been maintained, and companies have been forced to seek alternative markets in which to sell their steel, such as export markets. Since marginal costs (i.e., the cost of producing additional tonnages of steel) are relatively low, the incentive to export steel at prices that reflect low marginal costs is high, even when such prices are below the price prevailing in the export market and do not cover average total costs of production. Since the U.S. market has traditionally had relatively high steel prices (figure 4-3), it has often been subject to competition from such low-priced imports. This competition and the consequent deterioration in prices resulted in the filing of numerous dumping complaints by the U.S. industry during the late 1970s and 1980s. Since 1989, however, the U.S. market has not been as lucrative as in the past for foreign steel producers. Strong steel demand in Asia, and to a lesser extent, Europe, has raised steel prices in those markets. The diminished attractiveness of the U.S. market helps explain why competition from low-priced imports is significantly lower than in previous years. In 1989, exports from VRA countries filled only two-thirds of their export ceilings, whereas during 1984-87, ceilings were filled in almost all cases (see appendix E).

In addition to market conditions, industry structure affects the extent to which firms compete on price. The steel industry has traditionally been viewed as oligopolistic, with firms maintaining some influence over price. In recent years, however, the growth of reconstituted mills and minimills has changed the structure in the United States. With ongoing competition from imports, this has resulted in a more competitive market that has increased pressure on producers to reduce prices and costs. The downward pressure on prices has made the U.S. market relatively less attractive to foreign producers.

The ability of firms to compete in an increasingly price competitive market is predominantly a function of their costs. The lower a firm's costs, the more flexibility it has to maintain or expand market share by underselling competitors. While high cost, unprofitable firms can compete in the short run (as long as prices cover average variable costs), their ability to do so over the long run is limited by the diminished ability to generate the revenues required to maintain operations and invest in new plant and equipment. Ultimately such firms either have to lower costs and become profitable, or exit the market.

Figure 4-3
Steel prices by selected country, 1970-90: U.S. prices lowest by 1990



Note.—1990 prices are for January to September only.

Source: Compiled from statistics of PaineWebber.

Below is a discussion of the current cost competitiveness of the U.S. steel industry and an assessment of the factors likely to affect its future cost competitiveness.

Cost

Studies by independent steel industry analysts indicate that the U.S. steel industry was internationally cost competitive during 1990 and early 1991, particularly with respect to producers in Germany and Japan.[9] As seen in figure 4-4, the cost of producing steel in the United States relative to the costs of producing steel in Japan and major European countries has declined since 1982. This is the result of both the depreciation of the dollar and efforts by the U.S. industry to reduce costs.

In November 1990, U.S. costs for producing cold-rolled sheet, a key product produced primarily by integrated mills, were estimated to be one of the lowest in the world (table 4-3). At $494 per metric ton, the U.S. pre-tax cost was lower than it was in all other listed countries except the United Kingdom and Taiwan. With respect to Japan and Germany, the cost differential was substantial (13-16 percent). However, more recent cost estimates (see appendix H[10]) indicate that the U.S. steel industry has lost much of its cost advantage, primarily as a result of the rising value of the dollar.

Table 4-3 also reveals the cost challenge posed by minimills. Due primarily to low labor and financial costs, Nucor, a U.S. minimill that has recently begun to produce flat-rolled products, has steelmaking costs that are an estimated 14 percent below those of the lowest cost foreign producer, and 18 percent below the costs of U.S. integrated producers.[11]

With respect to hot-rolled bar and light structurals, products produced primarily by minimills, the United States appears to be generally competitive (table 4-4). U.S. costs (including taxes) are equal to those in Korea and the United Kingdom, and only slightly higher than those in Brazil. Compared to minimills in Germany and Japan, U.S. minimills generally have lower electricity, labor, and financial costs, resulting in an overall cost advantage of 5-10 percent. The greatest advantage of U.S. minimills lies in their high productivity. At 1.4 manhours per ton, U.S. minimills appear to have a 30-40 percent productivity advantage

[9] Although cost comparisons are problematic, they provide insight into the relative cost position of major steel-producing nations. The confidentiality of company cost data and the variability of costs with countries account for much of the discrepancies in estimated costs among various sources.

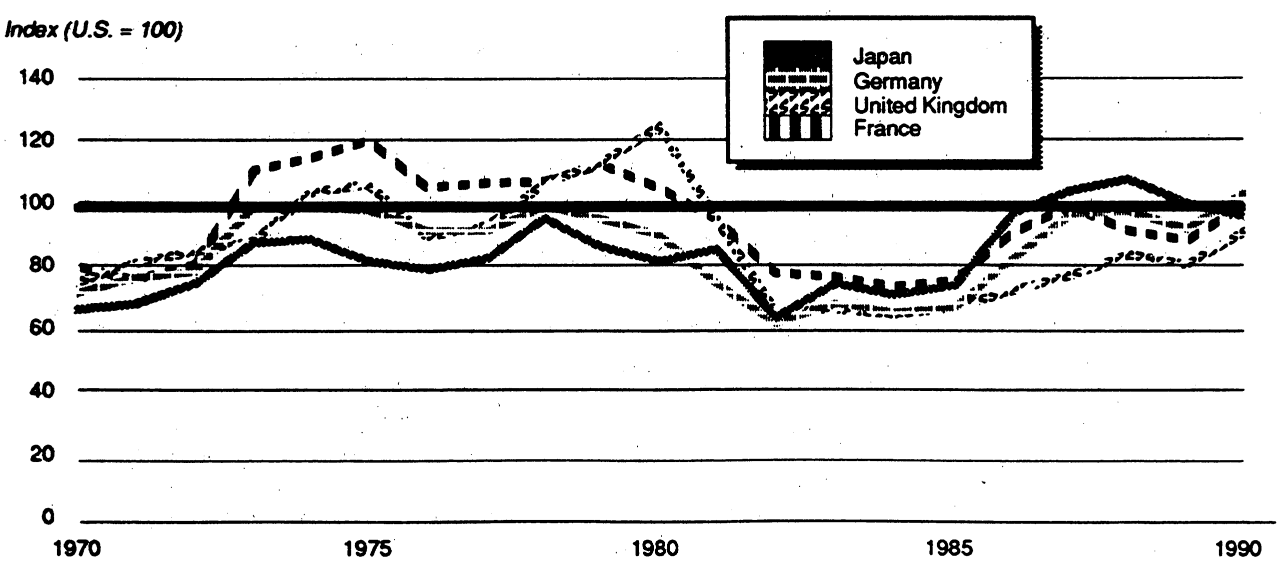
[10] Figures in appendix H may not be strictly comparable with those in table 4-3 as they use a different set of

10 —*Continued*

assumptions. For example, the tables assume different operating rates. A 10-percent difference in operating rates could account for a differential of $10-15 per metric ton.

[11] It should be noted, however, that Nucor's cold-rolled sheet is not deemed to be comparable in quality, particularly with respect to finish, which is of particular importance to steel consumers in the automotive and appliance industry. Because cost estimates do not factor in varying levels of quality and service, companies in countries characterized by above-average quality and service, particularly Japan, appear in the tables to be at a disadvantage that is not necessarily reflected in the market.

Figure 4-4
Pre-tax steelmaking costs, by selected country, 1970-90: Gap narrows by late 1980s



Note.—1990 costs are for January to September only.

Source: Compiled from statistics of PaineWebber.

Table 4-3
Cold–rolled sheet: Estimated costs, at standard operating rates, as of November 1990, by selected country

Item	United States	Japan	Germany	United Kingdom	France	Canada	Australia	South Korea	Taiwan	Brazil	Nucor thin–slab 1991
Assumptions:											
Exchange rate (local currency/U.S. dollar)	US$1.00	¥127.0	DM1.48	£0.51	FFr4.97	C$1.17	A$1.29	Won714	NT$26.8	Cr109.6	US$1.00
Operating rate[1] (percent)	90	90	90	90	90	90	90	90	90	90	90
Input/output ratio[2]	1.26	1.15	1.20	1.20	1.21	1.27	1.20	1.20	1.21	1.30	1.20
	(U.S. dollars per metric ton shipped)										
Raw materials cost:											
Coking coal	39	48	49	44	48	38	31	49	56	77	0
Iron ore/sinter	64	79	80	74	80	73	75	76	85	52	0
Scrap (before credits)	41	17	31	28	25	42	19	34	18	27	120
Total raw materials cost	144	144	160	146	153	153	125	159	159	156	[3]145
Energy and other materials cost[4]	174	184	172	172	170	160	182	168	172	207	177
Labor cost:											
Employment cost/hour	26.5	25	31	22	27	24.5	21	8	10	4	27
Manhours/ton	5.3	5.6	5.7	5.7	5.7	5.6	6.8	7.1	7.0	11.2	1.6
Total labor cost	141	142	178	128	147	136	144	57	70	45	43
Total operating cost	459	470	510	446	470	449	451	384	401	408	365
Financial Expense:											
Depreciation expense	25	70	49	23	38	30	25	125	68	80	40
Interest expense	10	20	13	1	13	17	28	16	11	50	0
Total financial expense	35	90	62	24	51	47	53	141	79	130	40
Pretax cost	494	559	573	471	521	495	503	524	480	538	405
Ranking (low cost is 1)	4	10	11	2	7	5	6	8	3	9	1

[1] Operating rate is the percent of a plant's effective capacity that is being utilized.
[2] Ratio of liquid steel to cold–rolled steel.
[3] Includes costs for direct reduced iron.
[4] Includes fluxes, alloys, and additives; refractories and rolls; miscellaneous materials costs; and state and local taxes.

Note.—Because of rounding, figures may not add to the totals shown.

Source: PaineWebber World Steel Dynamics, *Cost Monitor #13* (January 11, 1991), p. 12.

Table 4-4
Hot-rolled bar and light shapes: Estimated costs at actual operating rates as of second quarter, 1991

Item	*United States*	*Japan*	*Germany*	*United Kingdom*	*Korea*	*Brazil*
Assumptions:						
Exchange rate (local currency/ U.S. dollar)	US$1.00	¥140	DM1.75	£1.65	Won730	(1)
Operating rate[2] (percent)	85	85	90	90	95	85
	(Dollars per metric ton shipped)					
Scrap	124	130	130	125	136	143
Other materials	60	55	57	58	55	57
Energy:						
Electricity	29	46	41	36	41	24
Other energy	8	9	9	11	9	11
Total energy costs	37	55	50	47	50	35
Labor costs:						
Employment cost/hour	27	26	27	19	8.5	4.5
Manhours/ton	2.0	2.0	2.2	2.3	3.9	4.4
Total labor costs	54	52	60	43	33	20
Maintenance	9	8	9	9	9	10
Operating cost	284	299	306	283	282	264
Financial costs:						
Depreciation	10	18	16	15	15	15
Interest	14	15	13	12	13	17
Taxes	2	2	1	1	1	1
Total financial costs	26	35	30	28	29	33
Total cost	310	334	336	311	311	297
Ranking (low cost is 1)	2	5	6	4	4	1

[1] Not provided.
[2] Operating rate is the percent of a plant's effective capacity that is being utilized.

Note.—Due to rounding, figures may not add to totals shown.

Source: Donald F. Barnett, Economist.

over competitors in industrialized countries and a 60-70 percent advantage over competitors in developing countries.

Structural Components of Costs

Examining the structural components of costs is helpful in explaining why some producers are more cost competitive than others. Production costs can be categorized as either operating or financial costs. Operating costs, which cover the cost of producing and selling steel, serve as a valuable indicator of plant efficiency and reflect two primary factors: the price of inputs and the efficiency of their use. Whereas input prices are determined largely by market conditions, purchasing arrangements, and exchange rates, efficiency of input use depends on factors such as the condition and types of technology employed and the skill and effectiveness of the labor force. Financial costs, which include depreciation and interest expenses, are an important component in total costs in that they vary widely from one country to another.

Below is a brief discussion of the various elements of production costs. Cost estimates from table 4-3, which provides the most detailed breakout of costs for the most countries, are employed as the reference point.

Energy and raw material costs

Raw material costs are similar for major steel-producing nations. With the exception of Australia, which has abundant sources of iron ore and coal, the cost of raw materials per metric ton varies between $144 (in the United States and Japan) and $159 (in Korea and Taiwan). Part of the reason for the limited variability is that iron ore and coal, being global commodities, command a price that varies little by region. In some instances, however, steelmakers either own or have long-term commitments to specific mines, and are committed to source from them even when prices charged by such mines are above the world price.

With respect to efficiency of input use, adjustment efforts by U.S. producers have brought the relatively older facilities in the United States up to a level of efficiency that is equivalent to that in other major producing nations. Industries that have the highest continuous casting ratios, for example, will generally have the highest yield ratios (i.e., they will require less hot metal to produce the same finished product). As discussed in the technology section of chapter 3, U.S. continuous cast ratios have steadily improved throughout the 1980s, though they still lag behind rates in Europe and Japan.

With respect to scrap, the high expenditure level in the United States does not reflect high U.S. prices, but rather that U.S. steel producers generally use more scrap in their production process than most foreign producers.[12] The importance of the scrap price, however, lies not so much in its effects on international cost comparisons, but rather in its impact on the competitive position of minimills. Since scrap prices were generally depressed in the decade prior to the mid-1980s, minimills could produce liquid steel more cheaply than integrated producers. When the price of scrap increased from $80 per metric ton to $110 per metric ton in November 1987, a $20-per-ton cost advantage for minimills at the liquid steelmaking stage[13] became a slight cost advantage for integrated producers. The scrap price at which liquid steelmaking costs for integrated mills and minimills equalize is estimated to be approximately $90 per metric ton, (declining from $141 per metric ton in 1982). Scrap prices since 1990 have been approximately $100 to $113 per metric ton.[14]

Labor costs

Unlike materials costs, labor costs vary widely between industrialized and developing countries. Whereas labor costs per metric ton in industrialized countries range from $128 to $178, the costs in developing companies range from $43 to $70.

In terms of productivity, steel producers in industrialized nations have reduced the number of manhours per ton (mhpt) required to produce and ship a ton of cold-rolled steel from 11 to 27 mhpt in 1975 to 5 to 6 mhpt currently.[15] The productivity gap between steel producers in industrialized and developing countries is also narrowing, but remains significant. At 11 manhours per ton, Brazil's productivity is about half the productivity in industrialized countries.[16] The effect of lower productivity on costs in developing countries is, however, more than offset by wages that are one-fifth to one-third those in industrialized countries.

Because wages are denominated in home country currencies, exchange rate changes affect their level relative to foreign competition. For example, the appreciation of the dollar in recent months against the Korean won and new Taiwanese dollar has reduced wage rates (in dollar terms) in Korea and Taiwan.

Financial costs

Financial costs, the major portion of which are fixed, are also characterized by wide differentials. On the low end is the U.K. steel industry, whose $24 per metric ton in financial costs represents only five percent of total pre-tax costs. In contrast, Korea's financial expenses of $141 per metric ton represent one-quarter of pre-tax costs.

Financial costs include depreciation expenses, which reflect capital expenditures as well as depreciation practices. This explains why expanding industries, such as those in Korea, Taiwan, and Brazil, which invest relatively large sums of money, have the highest depreciation expenses. Financial costs also include interest expenses, which depend on interest rates and debt levels. That Japan's interest expenses are twice as large as those in the United States, in spite of relatively low interest rates in Japan, reflects the relatively high levels of debt used to finance activities in that country. The relatively low figure for the U.K. steel industry, on the other hand, reflects the forgiveness of British Steel's outstanding obligations when the company was privatized in 1988.

Transportation costs

The cost of producing steel provides an important element of potential price competitiveness. The other element is the cost of transporting steel. At roughly 25 cents per pound, steel is one of the cheapest materials by weight. Consequently, transportation costs, which are weight sensitive, often represent a significant portion of the total value of the delivered steel. In a sense, transportation costs help dictate the geographic arena in which a firm can be price and cost competitive.

The relative importance of transportation costs depends on four factors: (1) the distance from the mill to the consumer; (2) the mode of transportation available to transport the steel; (3) the product that is being transported, and (4) market conditions in the transportation industry. That transportation costs depend on distance is perhaps obvious, but the implications are important. As discussed in chapter 2, world trade in steel is dominated by trade within the European Community. In large part, this is due to the proximity of member nations. In terms of distance, shipping steel from Frankfurt to Paris is similar to shipping from Chicago to Cleveland. Alternatively, shipping steel from Cleveland to the West coast covers a distance greater than almost any within Europe. The distance between the United States and Europe or Asia provides a cushion to U.S. steel producers when European or Asian steelmakers sell in the U.S. market.

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[12] U.S. producers use more scrap in their BOF charge primarily because scrap is more available and the price is competitive. With a relatively low continuous casting ratio, U.S. steel producers generate more scrap internally.

[13] The cost advantage of minimills becomes greater, however, when comparisons are made at later stages in the steelmaking process.

[14] PaineWebber, *Steel Strategist #17* (February 1991), p. 106.

[15] PaineWebber, *Cost Monitor #13* (January 11, 1991), p. 3.

[16] Comparing labor productivity among companies and countries requires a high degree of estimation in light of the complexity and diversity of steelmaking technology in use, different product mixes, and different labor practices.

It presents a hurdle when U.S. producers export overseas.

Besides distance, transportation costs are affected by the mode of transportation employed. Steel can be transported via ship, rail, or truck. Most U.S. domestic shipments of steel are transported via rail and truck, and ocean shipping is used for import and export. Domestic rail and truck rates are slightly higher than ocean freight rates. As a result, Asian steelmakers typically face lower transportation costs ($70 per metric ton[17]) when shipping to the West coast than do U.S. steelmakers on the East coast (up to $145 per metric ton[18]). European steelmakers have a similar advantage over West coast producers when selling in the East coast. Since deregulation of the U.S. rail industry in 1980, however, lower domestic rail rates and improved rail service[19] have gradually diminished the transportation disadvantage of coast-to-coast shipments, according to several steel buyers on the West coast.[20]

The cost of transportation also varies according to the product being transported. Generally, steel that has been through more processing is more costly to ship. This is often because processed steel must be shipped by container (as opposed to breakbulk) carriers.[21] Shipping costs for wire products sent by container carrier from Europe can run as high as $110 per metric ton.[22] On the other hand, transportation costs impact most heavily on commodity grade products. Because of their low value, the cost of transportation represents a higher proportion of the overall cost. While shipping costs average between 5 and 10 percent of the selling price for imported steel products overall,[23] shipping costs for commodity-type steel products are usually closer to 10 percent, and may be as high as 20 percent when demand is weak and the selling price of steel products drops.

Steel imported from Europe, Japan, and to some extent, Korea, has evolved into a product mix weighted toward high quality, value-added products. Transportation of these products is often more costly, as they are characterized by small lot size. They also often have longer lead times and production periods that are not easily synchronized with regular ship sailings. However, producers of these higher value products usually benefit from strong mill-shipper relationships, which often makes it possible to assemble full shiploads of different types of steel before sailing. In addition, to the extent that these high-value products are in short supply, the consumer may be willing to pay more for delivery.

Much of the steel imported from newer sources, such as non-traditional Asian sources and South America, is generally less sophisticated, commodity grade steel. Suppliers in these countries may have a transportation cost advantage because of larger orders, longer leeway with respect to anticipated delivery dates (because few purchasers with strict time requirements will purchase from such sources), and less specialized handling requirements. These requirements result in less costly transportation choices, such as bulk steel shipping with unspecified dates for ports-of-call.

Finally, transportation costs depend on market conditions in transport industries. Ocean freight rates continue to be low, particularly on the Pacific Far East-to-U.S. routes, even for conference carriers.[24] Rates are only slightly higher on the Atlantic Europe-to-U.S. routes. The overall effect of such perennially depressed freight rates is that the variation in freight rates is not great enough to cause importers much concern except when the market prices for their products decline significantly. Where possible, shippers have reduced transportation costs through alternative shipping methods or major improvements in transportation logistics.

Cost Outlook

The frequency and magnitude of changes in real exchange rates appears to have the greatest potential for causing shifts in relative steelmaking costs worldwide. Their unpredictability complicates an assessment of how cost competitive principal producers will be. Dollar-denominated costs account for slightly more than one third the total costs for steel producers

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[17] This includes, in addition to ocean freight, inland transportation, loading and unloading, interest expense, duties, and commission. PaineWebber, *Steel Price Track #34* (Apr. 5, 1991), p. 20.

[18] U.S. International Trade Commission, *The Western U.S. Steel Market: Analysis of Market Conditions and Assessment of the Effects of Voluntary Restraint Agreements on Steel-Producing and Steel-Consuming Industries*, investigation No. 332-231, USITC publication 2165, March 1989, pp. 6-4. Note that figures above have been translated to a cost per metric ton basis.

[19] Some domestic producers and service centers are now able to provide just-in-time (JIT) delivery to users (particularly in the auto supply sector) by special rail arrangements with U.S. railroads. Previously, rail service was neither cheap nor efficient enough for this type of use. Truck was generally preferred over rail for its efficiency, but was substantially more expensive.

[20] Representatives of steel service centers, interviews by USITC staff, Los Angeles, December 1990. West coast steel consumers have indicated that in some instances, East coast steel is offered below the prevailing market price. See, for example, Frank Haflich, "Wheeling-Nisshin undercuts W. Coast," *American Metal Market*, May 23, 1991, pp. 1,4.

[21] Breakbulk refers to carriers that carry cargo in bales, barrels, slings etc. Breakbulk carrier cargo is handled directly by dock workers. The cargo of container carriers, which are more prevalent today, is transferred from factory to ship to truck or train while containerized, thereby avoiding handling by dock workers.

[22] Representative of steel importing company, telephone interview with USITC staff, Apr. 18, 1991.

[23] Representatives of various steel importers, telephone interview with USITC staff, April 1991.

[24] Conference carriers are carriers that have an agreement with one or more other carriers to set rates. The agreement must be approved by the Federal Maritime Commission so as not to violate anti-trust laws.

in Japan, Germany, the United Kingdom, and France.[25] Thus, a 15-percent appreciation of the dollar versus currencies in these countries translates into a relative increase of about 10 percent in U.S. production costs. By comparison, a 15-percent increase in U.S. wage rates or a 15-percent decrease in U.S. worker productivity translate into a relative increase of only 4-5 percent in U.S. production costs. Whereas wage rates and productivity changes affect only labor costs, exchange rate fluctuations affect labor costs as well as financial, energy, and materials costs.

Nevertheless, labor costs remain an important area of potential changes in cost comparisons. As mentioned above, labor costs vary considerably, and this largely reflects differences in wage rates. Pressures in developing countries to increase wages may limit their major source of cost advantage. In Korea, for example, such pressure resulted in wages increasing nearly 40 percent in local currency terms from 1988 to 1990.[26]

Although pressures to increase wages also apply to steelmakers in industrialized countries, other factors may weigh more heavily in the future. One factor particularly important to U.S. steelmakers is the rising cost of providing health care to workers. Health insurance payments to U.S. steelworkers[27] in 1991 were 173 percent higher than a decade ago; whereas health insurance payments accounted for 7 percent of total employment costs in 1981, they currently account for 15 percent.[28]

With respect to energy and raw materials, a number of recent developments may affect relative costs in the future. Environmental legislation, for example, forces steelmakers (particularly integrated steelmakers) to commit substantial resources to pollution control expenditures. Cokemaking is the steelmaking process most directly affected by the recently passed amendments to the U.S. Clean Air Act, and this could result in significant increases in the price of coke in the United States. To the extent that environmental legislation and enforcement of laws differ among steelmaking nations, relative production costs may change.

An increase in the price of scrap (relative to iron ore and direct-reduced iron) could negatively affect minimills, which use scrap as their main raw material input. Although integrated mills also use small amounts of scrap in steelmaking, they can generally vary the amount. As minimills expand and traditional integrated facilities use more electric furnaces, the demand for scrap will likely rise, which would put upward pressure on scrap prices.

Changes in financial costs may also alter the long term international cost competitiveness of steelmakers. Like labor costs, financial costs vary considerably by country. As discussed above, this is in part due to the varying rates of investment. Countries active in expanding capacity, and Korea in particular, have high depreciation expenses. As the process of expansion slows in those countries, investments will be limited to maintenance and upgrades, and consequently, depreciation costs are likely to decrease.

Finally, the nature and pace of implementing cost-saving technology can affect international cost comparisons. Profitable companies, such as those in Japan, may have greater resources to maintain or enhance their future cost competitiveness.

Quality and Service

Quality and customer service[29] are of growing importance to most firms in the steel industry and its customers in both the United States and abroad. Continuous improvement in quality has become essential to meet the needs of end-users, for whom defects in purchased steel can lower the efficiency of manufacturing operations or the quality of the final product. Demands that steel have customized characteristics or properties have become more common and increasingly stringent. In addition, improved service, including development of closer working relationships with customers, is essential to supply steel on a more competitive and timely basis.[30] Many global steel producers have achieved a significant competitive advantage over other domestic and foreign producers by focusing on quality and service.

Recent Efforts by U.S. Producers to Improve Quality and Service

In order to evaluate the quality and service improvements made by domestic producers and the current competitive position of the U.S. industry, the Commission surveyed different groups of steel purchasers in 1990.[31] More than 80 percent of steel

[25] PaineWebber, *Cost Monitor #13* (Jan. 11, 1991), p. 3.

[26] Calculated from statistics in PaineWebber, *Cost Monitor #13* (Jan. 11, 1991) and *Cost Monitor #11* (Dec. 5, 1988).

[27] Includes active employees and retirees.

[28] Representative of American Iron and Steel Institute, telephone interview with USITC staff, July 1991. 1991 figures are for the month of April.

[29] For a more detailed discussion of the elements that contribute to steel product quality and customer service, see U.S. International Trade Commission, *Steel Industry Annual Report on Competitive Conditions in the Steel Industry and Industry Efforts to Adjust and Modernize,* investigation No. 332-289, USITC publication 2316, September 1990, pp. 36-38.

[30] A discussion of the reasons for, and vehicles for achieving, quality and service improvements is contained in USITC, *Steel Industry Annual Report,* USITC publication 2316, pp. 36-39.

[31] The principal consuming groups identified in the tables and tabulations throughout this chapter are categorized by standard industrial code (SIC) as follows: metal cans and containers (SICs 3411, 3412); fabricated structural metal products (SICs 3441-3449); metal forgings/stampings (SICs 3462-3469); nonelectrical machinery and equipment (SIC 35); appliances (SIC 363); electrical equipment (SICs 361, 362, 364, 365, 366, 367,

purchasers responding to the Commission's questionnaire report at least limited improvements in product quality and customer service by U.S. steel producers during 1985-90. However, the extent of these improvements depends on the type of consumer.[32] The most significant quality and service improvements were reported by purchasers of steel for automobiles, whose large-volume orders and historical customer relationships have apparently been one of the strongest forces motivating U.S. steel producers to improve both product quality and customer service. (See appendix I, figures I-1 and I-2).

These findings are consistent with the substantial investments in new equipment that have been made by the industry in recent years (see technology section).[33]

The placement of full-time technical assistants at auto stamping plants has also been critical to improvements in automotive steel product quality, since it has enabled steel mills to become more involved in the production process from the initial phase of design through the stamping operations.[34] Improvements in customer service have been made by establishing closer ties with consumers, which has enabled steel mills to more accurately assess their customers needs. In addition, steel mills have increased their ability to offer just-in-time delivery, improved their reliability of delivery, and expanded electronic communication and data exchange.[35]

An examination of responses to the survey organized on the basis of purchaser size indicates that smaller consumers tend to observe less improvement in quality than their larger counterparts, although the extent of observed improvement in customer service is fairly similar among all size categories[36] (see appendix I, table I-1).

U.S. Producers' Current Status

The type of consumer (see tables 4-5 and 4-6 and appendix I, tables I-2 through I-11), rather than consumer size (see appendix I, table I-12), also appears to be the major factor determining consumer satisfaction with the existing overall quality and service of U.S. producers. As shown in table 4-5, consumers in the automotive and related parts (i.e., forgings) industries are among the most satisfied customers, whereas customers in the metal cans/containers and appliances industries appear to be among the least satisfied. Despite the increased satisfaction of auto producers with domestic steel product quality, they have indicated their intention to maintain demands on steel producers for continued quality improvement as a means to enhance their own competitiveness.[37] These needs are communicated through annual technical assistance meetings between auto producers and their steel suppliers, during which information on steel product performance and expectations is exchanged.[38] Certain suppliers (both foreign and domestic) interviewed during fieldwork indicated their intention to improve their service to customers by offering to provide certain downstream products and services in addition to basic steel mill products (for example, automotive steel combined with further processed automotive products such as springs and fabricated structural steel combined with the associated fasteners and installation services).

Although the majority of purchasers responding to the Commission's 1991 questionnaire reported no change in product quality or customer service from year-ago levels, there were a substantial number reporting improvements (see table 4-7). Continued improvements in automotive steel quality and service are in accordance with ongoing efforts of domestic

31 —*Continued*

369); automotive (SIC 3711, 3713, 3714); other transportation (including aircraft and parts, shipbuilding, and railroad equipment) (SICs 3715-3799), steel service centers (SIC 5051), processors (SICs 3315, 3316, 3317).

32 Discussions with steel consumers on the West Coast in December 1990 and in the Midwest in May 1991 confirm that although domestic steel product quality has improved in recent years, the extent of improvement varies by end user and product line. For example, some steel consumers, such as those producing parts for jet engines or other critical and technically demanding uses, have consistently sought and received high quality steel for their operations and consequently have observed little or no change in steel product quality.

33 Discussions with [* * *] confirmed that U.S. steel producers have consistently met automotive producers' increased product quality demands in recent years. Auto industry executives cited significant declines in steel rejection rates (often ranging from 5 to 10 percent in the early 1980s to less than 1 percent currently). Significant improvements in automotive steel product quality were also noted by various members of the steel service center industry (who often process steel for automotive end uses) during meetings with Commission staff in May 1991.

34 [* * *].

35 [* * *].

36 These findings may differ depending on the purchaser's geographic location. For example, Commission fieldwork conducted with steel purchasers on the West Coast revealed that larger purchasers tend to obtain better prices, quality, and service than do smaller ones. Discussions with steel buyers in the Midwest, however, did not confirm this tendency, although it was noted that under tight steel market conditions, auto producers may be able to obtain better quality steel than smaller-volume purchasers.

37 [* * *]. Auto producers noted that they regard steel producers' acquisition and implementation of product technology to be an important indicator of their ability to maintain and/or broaden product quality.

38 Auto producers have developed internal rating systems that evaluate their steel sheet suppliers on the basis of four primary criteria: quality, delivery, technology, and price. The ranking system is designed to encourage conformance to auto producers' steel specifications and to facilitate their choice of steel suppliers. [* * *].

Table 4-5
Purchasers' assessments[1] of overall U.S. steel product quality,[2] by consuming group, 1990

Consuming group	*Less than satisfactory*	*Satis- factory*	*Good*	*Excellent*	*No. of responses*
	Percent				
Metal cans/containers	22	56	22	0	9
Fabricated structural metal products	0	44	42	14	64
Metal forgings/stampings	4	29	67	0	24
Nonelectrical machinery and equipment	2	33	58	8	64
Appliances	0	64	27	9	11
Electrical equipment	3	39	58	0	31
Automobiles	1	32	60	6	77
Other transportation	0	69	23	8	13
Service centers	0	44	33	22	18
Processors	1	40	54	6	86

[1] Assessments of U.S. performance were made by purchasers for companies with whom they conducted business.

[2] The term "satisfactory" was defined in questionnaires as follows: periodic problems encountered, but problems are effectively resolved. "Good" was defined as "occasional minor problems." "Excellent" was defined as "virtually no problems encountered."

Note.—Totals may not add to 100 percent because of rounding. The number of responses exceeds the number of respondents, as respondents were asked to provide evaluations on up to six product groups.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 4-6
Purchasers' assessments[1] of overall U.S. customer service,[2] by consuming group, 1990

Consuming group	*Less than satisfactory*	*Satis- factory*	*Good*	*Excellent*	*No. of responses*
	Percent				
Metal cans/containers	11	67	22	0	9
Fabricated structural metal products	8	47	42	3	64
Metal forgings/stampings	8	50	38	4	24
Nonelectrical machinery and equipment	2	36	50	13	64
Appliances	0	64	18	18	11
Electrical equipment	23	26	52	0	31
Automobiles	4	25	65	7	77
Other transportation	8	69	15	8	13
Service centers	2	21	51	26	43
Processors	5	43	41	11	83

[1] Assessments of U.S. performance were made by purchasers for companies with whom they conducted business.

[2] The term "satisfactory" was defined in questionnaires as follows: periodic problems encountered, but problems are effectively resolved. "Good" was defined as "occasional minor problems." "Excellent" was defined as "virtually no problems encountered."

Note.—Totals may not add to 100 percent because of rounding. The number of responses exceeds the number of respondents, as respondents were asked to provide evaluations on up to six product groups.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

steel makers to better satisfy the needs of one of their most demanding customer groups.[39]

[39] Purchasers of steel for containers have reportedly recently intensified their quality and service demands of U.S. tin mill producers, suggesting that further improvements are expected. An official of the domestic can industry recently urged U.S. steelmakers to strengthen their commitment to quality, service and partnerships with their customers, with emphasis on more collaborative work on such items as gauge reduction, improved coating materials and alloy development. The spokesman called for material designed, developed and produced to help the can makers manufacture the finest product possible at a realistic cost,

U.S. Versus Japanese Producers

Domestic producers have narrowed, but not closed, the perceived gap in quality and service relative to their main foreign competitor, the Japanese steel industry (see tables 4-5 and 4-6, figures 4-5 and 4-6, and appendix I, tables I-13 through I-22). Questionnaire responses indicate that:

39—*Continued*

and for improved on-time performance, reduction of lead times and better inventory management. Roland H. Meyer, presentation at the annual meeting, of the American Iron and Steel Institute May 23, 1991.

Table 4-7
Purchasers' assessments of the nature of change in overall domestic steel mill product quality and customer service between 1990 and 1991, by consuming group[1]

	Nature of change					
	Quality			*Customer service*		
Consuming group	*Better*	*Same*	*Worse*	*Better*	*Same*	*Worse*
	Percent					
Metal cans/containers	55	45	0	55	45	0
Fabricated structural metal products	44	56	0	45	50	5
Metal forgings/ stampings	37	47	16	32	53	16
Nonelectrical machinery and equipment	24	73	3	34	63	3
Electrical equipment	40	50	10	30	60	10
Automobiles	45	55	0	45	52	3
Other transportation	11	89	0	21	79	0
Service centers	33	67	0	33	58	9
Processors	31	57	11	29	63	9

[1] As fewer than four responses were provided by purchasers in the appliance industry, their responses are excluded from this table.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

- Japanese companies more consistently offer a higher-quality product compared with the United States, although certain consumer groups expressed dissatisfaction with both U.S. and Japanese suppliers.

- Only Japanese companies were identified by a majority of steel processors and purchasers in any consuming group as having excellent overall steel product quality. This assessment was made by purchasers in the following industries: fabricated structural metal products (67 percent), nonelectrical machinery and equipment (60 percent), and steel processors (59 percent).

- U.S. producers were reported by each consuming group as lagging behind Japanese producers in overall customer service, with one notable exception—steel service centers.

Although the majority of respondents rated the quality of automotive steel produced by Japanese steelmakers higher than that of U.S. steelmakers, recent discussions with auto industry executives indicated that for many automotive end-uses, domestically produced steel is as good as, or better than, Japanese steel in terms of quality.[40] Figure 4-5 illustrates purchasers' evaluations of U.S. and Japanese steel quality for three of the largest consuming industries, including automotive. One of the largest gaps in perceived product quality occurred in the metal cans and containers industry, suggesting that despite improvements, U.S. tin mill producers have failed to match the advances achieved by Japanese producers.

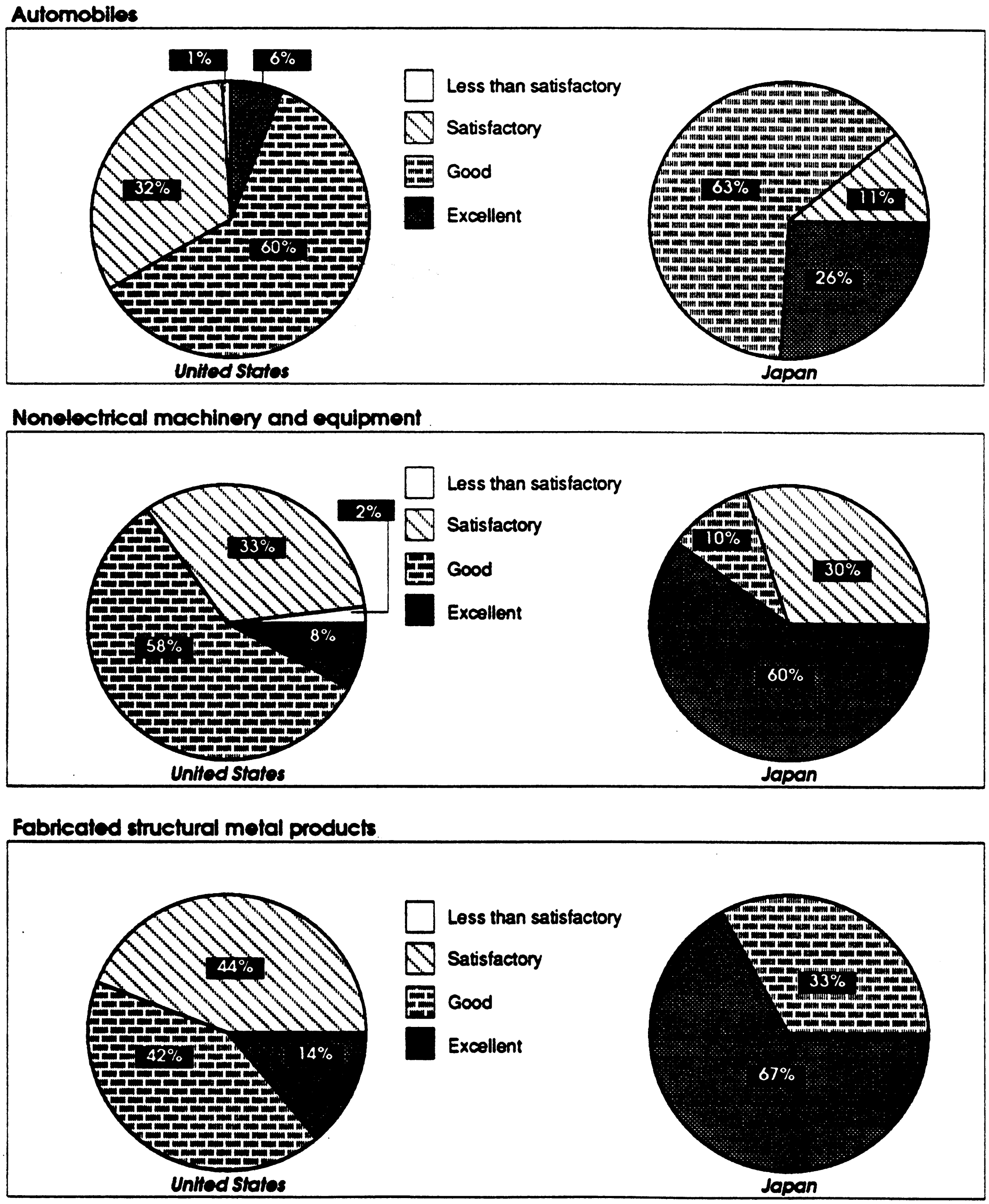
Improvements in customer service provided by U.S. steel producers are reflected in ratings of good-to-excellent by a majority of respondents in consuming groups producing automobiles,[41] nonelectrical machinery and equipment, electrical equipment, service centers, and processors. Figure 4-6 highlights these percentages for the three principal consuming groups. Discussions with major steel consumers indicated that U.S. steel producers have made notable improvements in delivery reliability and technical assistance; in addition, certain Japanese producers were noted to have reduced their overseas delivery times and improved their overseas packaging by encasing steel mill products in sealed steel containers (to avoid rusting at sea) and anchoring the goods aboard ship to avoid shifting and damage during transit.[42] Purchasers in the container industry, however, expressed dissatisfaction with both U.S. and Japanese customer service.

[40] [* * *]. It was noted that the surface quality of some Japanese automotive steel had deteriorated; a possible explanation offered was the increased activity in Japan's own automotive market which resulted in a significant increase in the volume of steel moving through the Japanese mills, partly at the expense of surface quality.

[41] During Commission fieldwork with major auto producers in May 1991 it was noted that domestic steel producers have considerably improved their delivery reliability, thereby achieving higher standards of customer service.

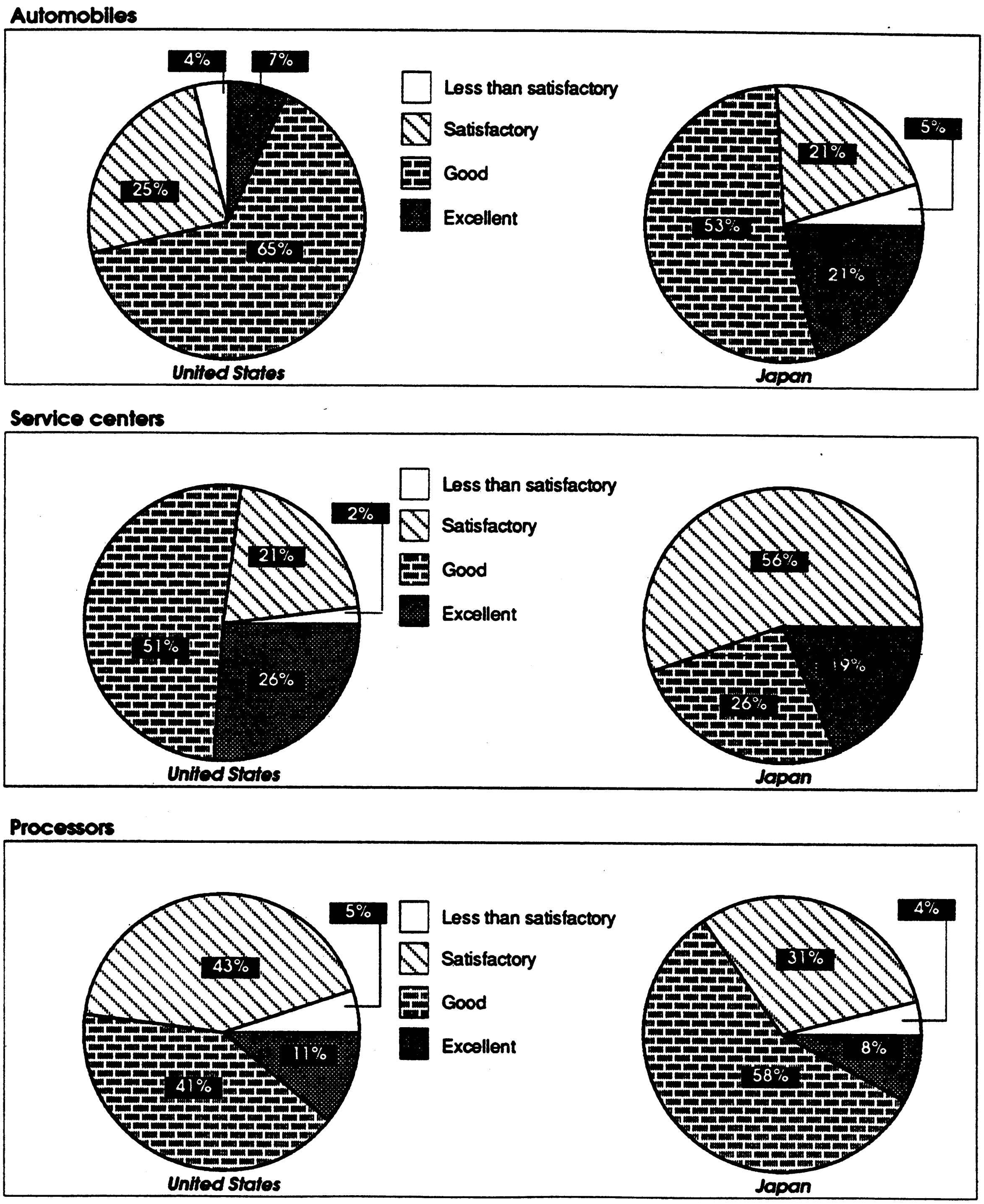
[42] [* * *]. Also, Frank Haflich, "NKK lessens delivery time," *American Metal Market*, Apr. 22, 1991; and Constance Grzelka, "The driving force behind Ford's steel," *American Metal Market*, Dec. 17, 1990, p. 18A.

Figure 4-5
Perceptions of U.S. and Japanese steelmakers' product quality, by selected U.S. consuming group, April 1990



Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Figure 4-6
Perceptions of U.S. and Japanese steelmakers' customer service, by selected U.S. consuming group, April 1990



Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

CHAPTER 5
CONCLUSIONS

The previous chapters address developments that have affected, and are affecting, the competitive environment in steel. The analysis suggests that the problems that adversely affected the industry and prompted government intervention have been in many cases essentially resolved. The imbalance between steelmaking capacity and consumption that precipitated restructuring throughout the industry, for example, has been significantly reduced. In the process, the incentives and willingness for governments to intervene have declined.

In developing countries, policies that were designed to develop steel capacity as a means to facilitate social and economic goals appear to be undergoing significant adjustment. For example, Brazil and Mexico, the two largest producers in Latin America, have initiated steps to privatize state-owned facilities.

The withdrawal of governments, however, is not universal. Governments in some countries, such as China and a number of other countries in Asia, continue to support expansion of steel capacity. Moreover, government ownership in steel companies throughout the world remains high, suggesting that governments may continue to have an interest in taking actions to protect their investment and advance broader social and economic goals. Moreover, it is not clear to what extent governments will be successful in withdrawing from the industry. The privatizations in Mexico and Brazil, for example, have yet to occur.

In the EC, Belgian and Italian state steelmakers have experienced difficulties in privatizing state owned steel mills, largely because of the debt loads carried by the respective steel firms. In other countries, like India, governments have found that the poor state of the industry necessitates continued government intervention.

Restructuring

The process of restructuring took various forms in principal steelmaking countries; in Europe, governments not only bore part of the cost of closing facilities, but also funded plant modernization and maintenance. As a result, companies in these countries emerged from the steel crisis in a relatively strong competitive position; the effects of such support will be felt for some time.

In the United States, the cost of restructuring fell primarily on the industry; relatively high costs, strong import competition, and growing competition from steel minimills, weakened the financial position of the industry and eroded its competitive position. In addition, appreciation of the dollar in the early 1980s, combined with a sharp decline in steel consumption, precipitated several billion dollars in operating losses and substantial reductions in capacity. A number of minimills and integrated producers were eventually forced to file for protection from creditors under U.S. bankruptcy laws.

The restructuring that took place significantly altered the character of the domestic industry. Large integrated producers sold or divested themselves of major segments of their business, as they sought to focus resources on the product area in which they were able to compete most effectively—sheet products. Within sheet products, they narrowed their focus on higher value, differentiated products, demand for which was particularly sensitive to quality and service. Their success in moving toward higher value products was facilitated through ties established with Japanese steel producers. Japanese investment included the acquisition of existing plants as well as joint ventures in new cold-rolling and electrogalvanizing facilities. Over a few short years, Japanese steel companies, which had been the biggest competitors for U.S. producers, became partners with most major U.S. integrated steelmakers.

Present Competitive Position of the U.S. Industry

Price

Steel consumers use different pricing criteria to make purchasing decisions. Interviews and statistical analysis performed by the Commission indicate that companies in some steel-consuming industries make purchase decisions principally on the basis of price. One example is the construction industry, which purchases plates, hot-rolled sheets, sheet piling, structurals, and hot-rolled bar (especially reinforcing bar).

Because the costs of U.S. integrated steelmakers are currently highly competitive with most foreign producers, it appears that they can compete effectively in supplying steel to the construction industry and other industries where price is a principal consideration. U.S. minimills have been competitive in the most price-sensitive markets all along.

The installation of advanced electric furnace and casting equipment, which are lowering the minimum efficient scale for producing many steel products, will likely improve the competitive position of domestic minimills as suppliers to the construction industry and other price-sensitive markets. With presently installed technology, domestic minimills are already capable of manufacturing most construction industry products. Integrated domestic producers, by contrast, are exiting some of the product markets that are important to the construction industry, such as the markets for merchant bars and structurals.

Quality and Service

Interviews and analysis conducted by the Commission also indicate that a number of consumers, such as the automotive, machinery, appliance, and can manufacturing industries, are particularly sensitive to differences in quality and service. Although price remains important, many firms in these industries are willing to pay a premium in order to receive high-performance products and specialized service. These industries principally consume hot- and cold-rolled sheet, coated sheet, tinplate (can industry), and special quality bars (automotive and machinery industries), all of which are predominantly manufactured by the integrated sector of the industry.

Commission survey results indicate that U.S. steelmakers have significantly improved their quality and service since 1985. Domestic steel consumers believe that U.S. steelmakers provide essentially the same level of service as Japanese steelmakers. Steel users have also noted the improved ability of U.S. steelmakers to manufacture products to more demanding specifications, although U.S. firms are regarded as still lagging behind Japanese companies in overall product quality.

Outlook

The competitive outlook for the major domestic integrated producers depends on a number of factors. Despite the improvements that have been made, they are still, for example, regarded as poor risks by the financial community. Steel industry bond ratings, as published by Moody's Investor Services, are the lowest of all major industries. Among the issues that cloud the future for the domestic steel industry are competition from competing materials in major markets, rising labor costs, competition from minimills and reconstituted mills (facilities that were sold and restarted as low cost independent companies), and the costs of meeting new environmental standards.

Smaller integrated mills, some of which are reconstituted, appear to have a different outlook. With some exceptions, they have not been able to obtain the kind of financial resources that the major integrated producers have obtained through joint venture partners, nor the technical support that accompanied these relationships. Many, however, have relatively low costs; their outlook depends critically on their ability to maintain low costs and to focus on markets where product differentiation is not critical. They appear to be more vulnerable to competition from minimills as well as imports from a relatively wide range of countries.

The competitive outlook for steel minimills will similarly be affected by a number of factors. Competition in product areas that they dominate will undoubtedly remain keen; domestic overcapacity reportedly exists in merchant-grade bars and light structurals and the construction industry supplied by minimills is highly cyclical. In the past, successful minimills have achieved their success by expanding market share in product areas traditionally dominated by integrated mills. Virtually the only area left is sheet products, which one minimill is already producing, and several others are likely to follow. Since this represents a relatively large market, it offers significant potential for expansion, particularly in the less sophisticated hot-rolled sheet products in which major integrated producers are not focusing.

Low production costs could enable minimills to expand market share and, as has happened in other products, provide opportunities to compete in the more sophisticated product areas over time. In the past, they have benefitted from favorable scrap prices; long term changes in the relationship of scrap prices to ore-based inputs could, of course, have a significant effect on their outlook.

The role of converters/processors seems likely to increase. Many of the joint ventures discussed above are, in effect, investments in processing capability, though the principal partners are themselves raw steel producers. Converters, however, also include mills where raw steel capability has been closed but rolling mills have been maintained. Economic and environmental considerations could well result in further reductions in raw steelmaking capacity while rolling capability is maintained.

A number of other factors explored in the study could impact the competitive position of the U.S. industry. Although displacement of steel by substitute materials may have leveled off in recent years, reductions in steel intensity may resume as certain consumers, particularly those in the automotive and container industries, discover new applications for plastic, aluminum, and other materials. While the industry is making efforts to hold on to markets, its success is not assured.

While declining consumption is not a phenomenon unique to the United States - steel consumption is decreasing among most industrialized countries - the implications for the U.S. industry may be somewhat different than for other industrialized counties. Since U.S. steelmakers lack the export base of many of their competitors, it is more difficult to counter downturns in domestic consumption with an increase in exports. Recently, however, the U.S. industry has increased its level of exports, both in absolute terms and as a percent of shipments. Further development of export markets would provide greater flexibility for the domestic industry.

Exchange rates are another factor affecting all segments of the industry; the extent to which they fluctuate can have a considerable effect on relative costs, which, in turn, can significantly affect trade flows. In the absence of a relatively dramatic appreciation of the dollar, it appears unlikely that imports of foreign steel will trigger a crisis of the same magnitude as experienced during the early 1980s. As noted, the ability of the U.S. steel industry to compete with foreign steelmakers in terms of price, quality, and service has improved since 1985. Should the dollar appreciate significantly, however, firms which compete mainly on the basis of price would likely experience increased competition and reduced earnings. Reconstituted mills and integrated mills that focus on undifferentiated products would likely be vulnerable. Firms focusing on highly specialized products, in contrast, would be relatively less affected by an appreciation of the dollar.

CHAPTER 6
U.S. INDUSTRY CONDITIONS

This chapter provides an overview of changes in various market indicators, including: apparent consumption and import penetration; production and capacity; capital expenditures; employment and productivity; financial conditions; and prices. While data are presented for the period 1980-90/91, the analysis focuses on recent changes in these categories.

Market Conditions

- ***Consumption:*** U.S. apparent steel consumption peaked in 1988, remained relatively stable during 1989-90 and fell markedly during January-May 1991 (table 6-1). This drop largely reflects a reduction in the levels of domestic shipments to the construction, automotive, and agricultural industries.

- ***Exports:*** Increased exports during 1989 and 1990 helped support industry shipments. The ratio of exports to shipments increased from 2.5 percent to 5.4 percent between 1988 and 1989, and to 7.8 percent during January-May 1991. Increased shipments to Canada, Mexico, and Korea have accounted for most of the increased export tonnage during 1991.

- ***Imports:*** After falling for six consecutive years, the import penetration ratio (imports as a percentage of apparent consumption) increased during January-May 1991, to 19.6 percent; the expansion reflects increased interest in the U.S. market due to both the appreciating dollar and declining consumption in many foreign markets.

Capacity And Production

- ***Capacity:*** U.S. raw steelmaking capacity increased in 1990 for the third year to 116.7 million short tons, a 4-percent increase over the 1988 level. Industry statistics indicate a further increase to 119.1 million short tons is likely for 1991 (table 6-2).

- ***Production and capacity utilization:*** U.S. steel production remained relatively stable during 1987-90, averaging 98 million short tons. As capacity increased however, capacity utilization rates declined from 89 to 85 percent during the three years. A combination of increased capacity and reduced production levels resulted in a capacity utilization rate of 72.2 percent for January-May 1991 (table 6-2). Data submitted in response to Commission questionnaires indicate that capacity utilization was highest in carbon steel wire rods and lowest in stainless hot-finished bars among the product areas surveyed (see appendix J, table J-3).

Table 6-1
Steel: U.S. shipments, imports, exports, apparent consumption, import penetration, and exports as a percent of shipments, 1980-90, and January-May, 1990-91

Period	*Shipments*	*Imports*	*Exports*	*Apparent consumption*[1]	*Import penetration*[2]	*Exports/ shipments*
	Thousand short tons				*Percent*	
1980	83,853	15,495	4,101	95,247	16.3	4.9
1981	88,450	19,898	2,904	105,444	18.9	3.3
1982	61,567	16,663	1,842	76,388	21.8	3.0
1983	67,584	17,070	1,199	83,455	20.5	1.8
1984	73,739	26,163	980	98,922	26.4	1.3
1985	73,043	24,256	932	96,367	25.2	1.3
1986	70,263	20,692	929	90,026	23.0	1.3
1987	76,654	20,414	1,129	95,939	21.3	1.5
1988	83,840	20,891	2,069	102,622	20.4	2.5
1989	84,100	17,321	4,578	96,843	17.9	5.4
1990	84,981	17,169	4,303	97,847	17.5	5.1
Jan.-May						
1990	35,485	6,437	1,739	40,183	16.0	4.9
1991	31,934	7,167	2,489	36,612	19.6	7.8

[1] Apparent consumption is defined as shipments plus imports minus exports.
[2] Import penetration is defined as imports as a percent of apparent steel consumption.

Note.—Data on shipments include material imported by steel producers for further processing. Apparent consumption is therefore overstated. U.S. International Trade Commission staff estimate the overstatement to be approximately 2.3 million net tons in recent years.

Source: American Iron and Steel Institute, *Annual Statistical Report,* various issues and monthly publications.

Table 6-2
Steel: U.S. raw steelmaking production, capacity, capacity utilization, and share of continuously cast steel, 1980-90, and January-May, 1990-91

Period	*Production*	*Capacity*	*Capacity utilization*	*Share of continuously cast steel*
	— *Million short tons* —		— *Percent* —	
1980	111.8	153.7	72.8	20.3
1981	120.8	154.3	78.3	21.6
1982	74.6	154.0	48.4	29.0
1983	84.6	150.6	56.2	32.1
1984	92.5	135.3	68.4	39.6
1985	88.3	133.6	66.1	44.4
1986	81.6	127.9	63.8	55.2
1987	89.2	112.2	79.5	59.8
1988	99.9	112.0	89.2	61.3
1989	97.9	115.9	84.5	64.8
1990	98.9	116.7	84.7	67.4
Jan.-May				
1990	41.1	34.9	85.0	66.4
1991	35.6	25.7	72.2	75.8

Source: American Iron and Steel Institute, *Annual Statistical Report*, various issues and monthly publications.

- ***Continuous casting:*** The share of steel produced using continuous casters, a technology that increases efficiency and improves product quality, has continued to increase. During January-May 1991, 75.8 percent of steel production was continuously cast, an increase of 9.4 percentage points compared with the corresponding period in 1990.

Capital Expenditures and Research and Development

- ***Level of expenditures:*** According to industry data, capital expenditures increased for the fourth consecutive year in 1990, rising to $2.5 billion (table 6-3). During 1980-90, the industry spent $20.6 billion on plant and equipment; cash generated from operations was an equivalent amount.

- ***Type of expenditures:*** Data collected by the Commission through questionnaires indicate that 96 percent of expenditures were directed to carbon steel operations; sheet and strip facilities accounted for the largest share of expenditures (36 percent) on these operations (see appendix J, tables J-19 through J-22).

- ***Research and development:*** Data collected by the Commission through questionnaires indicates that the industry spent [***] million on research and development in 1990; the largest expenditures were related to carbon steel sheet and strip operations (appendix J, table J-23).

Employment

- Total employment in the steel industry fell in 1990 for the second consecutive year, although the number of production workers increased (table 6-4). Wages and total compensation for steel industry workers were higher than for manufacturing workers in general; the differential between earnings and compensation in the steel industry and all manufacturing has remained at approximately the same level.

Financial Conditions

- ***Profitability:*** Between 1989 and 1990, operating income in the industry declined by approximately 50 percent to $1.3 billion. The industry as a whole recorded a net loss of $220 million (table 6-5). Data collected by the Commission indicate that financial performance continued to decline in 1991, as operating losses equalling 1.5 percent of sales were recorded (see appendix J, table J-5). Not all segments were equally affected, however; minimills, converters and specialty steel producers remained profitable, though each experienced declines of several percentage points. With respect to products, the greatest losses occurred in carbon hot-rolled sheet and strip, a product typically manufactured by the integrated sector, whereas the highest returns were in the specialty steel sector among the stainless plates, pipes, and tubes product lines (see appendix J, table J-6).

Table 6-3
Steel: U.S. steel industry capital expenditures and cash flow from operating and financing activities, 1980-90[1]

(In million dollars)

Period	Capital expenditures	Cash flow from — Operating activities[2]	Financing activities[3]
1980	2,650.6	2,542.6	602.1
1981	2,370.6	3,549.4	(692.0)
1982	2,258.2	956.3	1,766.0
1983	1,850.2	(393.7)	1,556.0
1984	1,203.1	650.3	296.1
1985	1,640.9	1,029.4	352.5
1986	862.0	2,272.0	(1,239.1)
1987	1,163.9	2,014.2	(541.2)
1988	1,838.5	3,434.0	(397.2)
1989	2,272.6	3,515.2	(734.6)
1990	2,499.5	993.8	1,084.1
Total	20,610.1	20,563.5	2,052.7

[1] Reported by companies representing 71.0 percent of the industry's raw steel production in 1990. Financial data for other years are based on results of companies representing varying percentages of the entire industry.
[2] Cash flow provided from operating activities includes net income, depreciation, deferred income taxes, and other non-cash items plus net changes in working capital.
[3] Financing activities include net transfers from non-steel operations, net changes in long-term and short-term debt, and net equity transactions.

Sources: American Iron and Steel Institute, *Annual Statistical Report*, various issues.

Table 6-4
Employment: Average annual employment, productivity, nominal earnings and nominal compensation for production workers in steel and all manufacturing, 1980–90

Period	Number of workers		Productivity		Nominal earnings[1]		Nominal compensation[2]	
	Total	*Production*	*Steel*	*Manufacturing*	*Steel*	*Manufacturing*	*Steel*	*Manufacturing*
	– Thousands–		– 1980=100 –		Dollars per hour			
1980	511.9	395.7	100.0	100.0	11.39	7.27	17.46	9.84
1981	506.1	391.6	108.8	101.3	12.60	7.99	19.04	10.84
1982	396.2	293.9	88.3	103.5	13.35	8.49	22.72	11.64
1983	340.8	256.3	113.5	108.7	12.89	8.83	21.14	12.10
1984	334.1	256.8	127.6	113.9	12.98	9.19	20.26	12.51
1985	302.6	231.5	135.6	118.8	13.33	9.54	21.43	12.96
1986	273.5	208.8	137.8	124.2	13.73	9.73	21.95	13.21
1987	268.4	202.9	148.0	130.8	13.77	9.91	22.61	13.40
1988	278.5	215.5	163.6	136.7	13.98	10.18	23.57	13.85
1989	277.7	214.2	161.1	138.0	14.25	10.47	23.49	14.31
1990	270.7	207.6	[3]167.9	[3]141.6	14.82	10.84	[3]24.29	[3]14.83

[1] Including overtime earnings.
[2] Compensation includes both direct and indirect payments to workers. Direct payments include payment for time worked (e.g., wages), payment for time not worked (e.g., vacation and holiday pay), bonuses, and other incentive or special pay. Indirect payments include employer contributions to legally required insurance programs and contractual and private benefit plans.
[3] Preliminary.

Source: Compiled from official statistics of the U.S. Department of Labor, Bureau of Labor Statistics.

Table 6-5
Steel[1]: U.S. steel industry total net sales, operating income, operating income as a percent of sales, net income, and net income as a percent of sales, 1980–90

Year	Net sales[2]	Operating income[3]	Net income[4]	Operating income/sales		Net income/sales	
				Steel	*Manufacturing*	*Steel*	*Manufacturing*
	Million dollars			Percent			
1980	37,163	627	681	1.7	6.7	1.8	4.9
1981	43,109	2,125	1,653	4.9	6.8	3.8	4.7
1982	28,239	(2,614)	(3,384)	(9.3)	5.1	(12.0)	3.5
1983	24,463	(1,143)	(2,231)	(4.7)	5.9	(9.1)	4.1
1984	30,005	516	(31)	1.7	6.8	(0.1)	4.6
1985	28,272	72	(1,834)	0.3	5.8	(6.5)	3.7
1986	24,875	666	(4,150)	2.7	5.6	(16.7)	3.7
1987	26,933	1,793	1,077	6.7	6.6	4.0	4.8
1988	32,466	3,349	(567)	10.3	7.3	(1.7)	5.9
1989	31,525	2,636	1,597	8.4	6.6	5.1	5.0
1990	29,425	1,300	(220)	4.4	6.1	(0.7)	4.0
Total	336,475	9,327	(7,409)	2.8	6.0	(2.2)	4.2

[1] Reported by companies representing 71.0 percent of the industry's raw steel production in 1990. Financial data for other years are based on results of companies representing varying percentages of the entire industry.
[2] Net sales is defined as the net billing value of products shipped, and does not include other income.
[3] Operating income is defined as net sales minus the cost of labor, materials and transportation services, and depreciation expenses.
[4] Net income is defined as total revenues minus total costs, and may include figures net of asset sales, restructuring costs, and other extraordinary items net of taxes.

Source: American Iron and Steel Institute, *Annual Statistical Report*, various issues; U.S. Department of Commerce, Bureau of the Census, *Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations*, various issues.

- *Debt:* After declining for four consecutive years, industry debt increased in 1990 to $5.6 billion (table 6-6). The industry's debt/equity ratio equaled 2.42 in 1990, which was several times higher than the average for all manufacturing industries.

Table 6-6
U.S. steel industry debt and debt to equity ratios for steel industry and all manufacturing, 1980-90

Year	Debt[1]	Debt/equity ratio	
		Steel	All manufacturing
	Million dollars		
1980	6,950.6	0.48	0.44
1981	6,430.2	0.42	0.45
1982	8,015.7	0.71	0.48
1983	7,464.1	0.89	0.45
1984	6,951.4	0.72	0.47
1985	7,169.0	1.00	0.52
1986	5,709.5	2.16	0.57
1987	5,684.7	1.84	0.61
1988	5,428.3	2.35	0.65
1989	4,677.8	2.12	0.73
1990	5,627.1	2.42	0.74

[1] Debt data from AISI do not include short term loans from banks, commercial paper or other short term debt, and are consequently understated by 5-10 percent.

Source: American Iron and Steel Institute, *Annual Statistical Report*, various issues; U.S. Department of Commerce, Bureau of the Census, *Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations*, various issues.

Prices[1]

- Prices for steel mill products declined by 1.7 percent between 1989-90, as compared to a 5.0 percent increase in manufacturing industries generally, and a 3.5 percent price increase in industries producing finished goods (table 6-7). Data submitted by steel purchasers in response to Commission questionnaires indicate that prices began to decline during the second half of 1990 and continued to decline during the first quarter of 1991 (see appendix J, tables J-7 through J-12).

Table 6-7
Indexes of U.S. producer prices for steel mill products, all manufacturing industries, and finished goods, 1980-90 (1980=100.0)

Year	Steel mill products	Manu-facturing industries	Finished goods
1980	100.0	100.0	100.0
1981	111.5	109.2	110.3
1982	115.5	113.6	116.3
1983	116.1	115.5	119.0
1984	120.2	117.8	122.0
1985	120.4	119.0	124.9
1986	115.2	117.3	127.6
1987	118.0	119.8	130.0
1988	127.5	122.7	134.3
1989	132.0	129.1	139.9
1990	129.8	135.5	144.8

Source: U.S. Department of Labor, Bureau of Labor Statistics.

[1] Certain revised price data for 1989 and first quarter 1990 can be found in appendix I, tables I-13 through I-18.

CHAPTER 7
MAJOR COMPANY ANALYSIS

Under the Trade and Tariff Act of 1984 (Public Law 98-573) (the Act), as amended, the President is required to make an annual determination to the Committee on Ways and Means of the House of Representatives and the Committee on Finance of the Senate regarding: (1) the commitment of net cash flow by major companies to steel projects; (2) worker retraining commitments; and (3) efforts taken by the major companies to maintain their international competitiveness.

The request for this investigation from the United States Trade Representative asked the Commission to develop information to assist in this determination. In addition, information was requested on the amounts used to retrain displaced former employees (as compared to amounts used for active employees), and on the compensation of executives (see appendix A).

The Commission developed the requested information through fieldwork, company reports, a review of secondary literature, and through questionnaires sent to the nine companies that met the statutory definition of major company.[1] Data were collected on actual cash flow for the October 1, 1990 to May 31, 1991 period; companies were requested to estimate data for the balance of the 12-month period (i.e., June 1, 1991 to September 30, 1991).

Net Cash Flow And Cash Flow Commitments

Under the Act, the President is required to determine whether:

> "... the major companies of the steel industry, taken as a whole, have, during the 12-month period ending at the close of an anniversary referred to in the [Act], ... committed substantially all of their net cash flow from steel product operations for purposes of reinvestment in, and modernization of that industry through investment in modern plant and equipment, research and development, and other appropriate projects such as working capital for steel operations and programs for the retraining of workers."

As reflected in table 7-1,[2] net expenditures for steel plant and equipment exceeded cash flow during the October-May period; forecasts for the balance of the period suggest that this will continue to be the case for the full 12-month period.

Table 7-1
Major steel companies' cash flow and expenditures, Oct. 1, 1990 to Sept. 30, 1991
(In thousands of dollars)

Period	Cash flow	Expen-ditures
Oct. 1, 1990–May 31, 1991	146,568	1,721,870
June 1, 1991–Sept. 30, 1991[1]	52,256	881,295
Total	198,824	2,603,165

[1] Based on company forecasts.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Expenditures On Worker Retraining

Expenditures' Share of Cash Flow

In addition to the determination regarding cash flow and cash flow commitments, the President is required, under the Act, to determine whether:

> "... each of the major companies committed for the applicable 12-month period not less than 1 percent of net cash flow to the retraining of workers; except that this requirement may be waived by the President with respect to a major company in noncompliance, if he finds unusual economic circumstances exist with respect to that company."

As reflected in table 7-2, each company that had positive adjusted net cash flow had expenditures on worker retraining that exceeded 1 percent of cash flow during the October 1, 1990-May 31, 1991 period; forecasts for the June 1, 1991-September 30, 1991 period suggest that such expenditures will continue to exceed 1 percent.[3]

Retraining of Current and Displaced Workers

Substantially all of the steel industry's retraining expenditures appear to have funded the development of skills among currently-employed workers. As shown in table 7-3, the major integrated producers spent $63.3 million (99 percent) of total retraining expenditures to retrain current workers during October 1, 1990-May 31, 1991. The balance of retraining expenditures ($455,000) was spent to retrain displaced workers. Estimates for the 4-month period beginning June 1, 1991, indicate that expenditures to retrain current workers will continue to account for substantially all retraining expenditures.

[1] Major company was defined as a company producing both iron and steel, and having raw steel production exceeding 2.0 million tons in 1990. It does not include any minimills, as they do not produce iron (a product of blast furnaces).

[2] See appendix K for further documentation on the calculation of cash flow and cash flow commitments for the current period, as well as final data for the October 1, 1989 to September 30, 1990 period. See the 1989 and 1990 surveys (USITC publications 2226 (October 1989)

2—Continued

and 2316 (September 1990)) for further discussion of the calculation of cash flow and commitments.

[3] See appendix K for further information on the calculation of worker retraining commitments.

Table 7-2
Major steel companies' retraining expenditures as a percent of adjusted net cash flow, by company, Oct. 1, 1990–May 31, 1991 and June 1, 1991–Sept. 30, 1991

Company	*October 1990–May 1991*	*June 1991–September 1991*[1]	*Total*
Armco			
Bethlehem			
Inland			
LTV			
National	* *	* *	*
Rouge			
USX			
Weirton			
Wheeling Pittsburgh			

[1] Estimated.
[2] Not applicable; negative real or anticipated net cash flow.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 7-3
Expenditures for the retraining of displaced and current workers, by company, by specified period

(In thousands of dollars)

Company	*Estimate: Oct. 1, 1990–May 31, 1991*	*Total June 1, 1991–Sept. 30, 1991*	*Oct. 1, 1990–Sept. 30, 1991*
Displaced workers:			
Armco			
Bethlehem			
Inland			
LTV			
National	*	*	*
Rouge			
USX			
Weirton			
Wheeling–Pittsburgh			
Subtotal	455	262	717
Current workers:			
Armco			
Bethlehem			
Inland			
LTV			
National	*	*	*
Rouge			
USX			
Weirton			
Wheeling–Pittsburgh			
Subtotal	63,350	25,679	89,029
Total retraining expenditures:			
Armco			
Bethlehem			
Inland			
LTV			
National	*	*	*
Rouge			
USX			
Weirton			
Wheeling–Pittsburgh			
Total	63,805	25,941	89,746

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Nature Of Retraining

Information provided by the major integrated producers indicates that retraining efforts in 1990 principally focused on the operation of modernized equipment and the development of technical steelmaking skills. Such programs are designed to maximize the benefits derived from the implementation of quality-enhancing or labor-saving technologies. In addition, other, more transferable skills were introduced to workers, such as personal computer, data processing, masonry, welding, pipe-fitting, and air conditioning repair skills. Several companies indicated that workers attended safety classes to ensure that fewer on-the-job injuries would occur. Finally, some companies indicated that workers attended remedial reading and mathematics courses and received training to develop communication and interactive skills.

Individual Company Retraining Programs

A description of the retraining programs sponsored by each of the major integrated producers follows.

Armco Steel Company, L.P.

* * * * * * * * * * * * *

Bethlehem Steel Corp.

* * * * * * * * * * * * *

Inland Steel Company

* * * * * * * * * * * * *

LTV Steel Corporation

* * * * * * * * * * * * *

National Steel Corporation

* * * * * * * * * * * * *

Rouge Steel Company

* * * * * * * * * * * * *

United States Steel (USS) Div. of USX Corporation

* * * * * * * * * * * * *

Weirton Steel Corporation

* * * * * * * * * * * * *

Wheeling-Pittsburgh Corporation

* * * * * * * * * * * * *

Executive Compensation

Direct compensation of steel industry executives in the form of salary (including the deferred portions of salary) accounted for about 69 percent of total compensation at the nine major steel companies in 1990. Other direct compensation (e.g., bonuses) totalled about 22 percent (table 7-4). Indirect compensation accounted for about 9 percent of total compensation.

Salaries of steel industry chief executive officers in 1990 ranged from [* * *] to [* * *], with an average of $377,000, compared to $441,000 in 1989. The median annual compensation of for CEOs in manufacturing industries was 700,000 in 1989.[4]

The average of salaries and bonuses (direct compensation) for steel industry CEO's was $607,000 in 1990, compared to $591,000 in 1989. Total compensation in 1990 for the CEOs at the nine major steel companies ranged from [* * *] to [* * *], compared to [* * *] to [* * *] in 1989.

[4] The Conference Board, *Information for the Press*, Release #3826, 1991.

Table 7-4
Executive compensation: Direct and indirect compensation for chief executive officers and other officers at major steelmaking companies during 1990

(In thousands of dollars)

	Direct compensation[1]				
	Salary	Other	Indirect compensation[2]	Total	Average per officer
Chief executive officer[3]	3,397	2,074	866	6,337	704
Other officers	15,514	4,092	1,628	21,234	204
Total	18,911	6,166	2,494	27,571	244

[1] Direct compensation includes the amount of gross salary, including any amount of salary deferred for company plans; other direct compensation includes any bonus awarded (including any amounts deferred to a subsequent year), including profit sharing and/or incentive compensation, and/or performance awards, and fees.
[2] Indirect compensation refers to forms of compensation which may be awarded to the employee such as company contributions made for stock, stock option and other stock plans, pension plans, thrift or investment plans, and all other benefits such as life, health, or legal insurance plans.
[3] The chief executive officer is defined as that employee of the company who has ultimate executive authority.
Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Average 1990 salaries of 104 other executive officers at the major steelmaking companies ranged from [* * *] to [* * *], compared to a range of [* * *] to [* * *] in 1989. Average total compensation figures ranged from [* * *] to [* * *] in 1990, compared to a range of [* * *] to [* * *] in 1989.

Efforts to Maintain Competitiveness

In order to maintain or enhance their competitive position, the major integrated producers continued modernization programs during 1990 and 1991. Modernization programs principally targeted production and customer service facilities, where efforts were made to improve quality and reduce costs. This section discusses efforts made by the major integrated steel companies to maintain competitiveness by modifying their market focus (i.e., product mix), entering into joint ventures with foreign partners, restructuring, and enhancing their marketing and customer service efforts.[5]

Market Focus

Higher Value-Added Products

Integrated producers are continuing to increase their focus on higher value-added product lines, principally those for flat-rolled products. Armco Steel Company, LP (Armco), for example, is planning to increase flat-rolling capacity by modernizing its Middletown, Ohio and Ashland, Kentucky plants.[6] Inland Steel is continuing its efforts to focus on high quality sheet and bar products by improving process technologies used in their manufacture; I/N Tek, a joint venture with Nippon Steel, is utilizing an advanced continuous process technology that reduces processing time for a steel coil from 12 days to less than 1 hour.[7] Weirton Steel, the nation's largest producer of tin mill products, will attempt to maintain its position in tin mill markets by improving the gage and drawing characteristics of its sheet products.[8] The extent to which producers are focusing on flat rolled products is reflected in table 7-5, which shows that sales of sheet and derivative products, such as galvanized sheet or tin mill products, account for nearly 80 percent of these companies' sales.

Coated Products

The integrated producers are also focusing investment in their coating facilities, which are principally galvanizing (zinc coating) lines. Armco is constructing a new electrogalvanizing line and is planning to install a hot-dip galvanizing line at its Middletown, Ohio plant.[9] Bethlehem is installing three new coating lines for galvanized sheet products and has completed a new tin mill pickling line at the company's Sparrow's Point, Maryland plant.[10] I/N Kote, a joint venture between Inland Steel and Nippon Steel, is

[5] See appendix L for detail on efforts by individual major companies.

[6] [* * *].

[7] Inland Steel Industries, *Annual Report*, 1990, p. 4, and Charles J. Labee and Norman L. Samways, "Developments in the Iron and Steel Industry, U.S. and Canada-1990," *Iron and Steel Engineer*, February 1991, p. D-16.

[8] [* * *].

[9] [* * *].

[10] [* * *] and Labee and Samways, "Developments," pp. D-5, D-7, and D-40.

Table 7-5
U.S. integrated steel producers: Percent of total value for firm represented by selected product line

Firm	Semi-finished steel bars	Plate	Hot rolled sheet and strip	Cold rolled sheet and strip	Galv. sheet and strip	Other sheet and strip	Bars and cert. shapes	Wire rod	Wire and wire prods	Struc. shapes, units	Rails and related prods	Pipe and tube
Armco ... Bethlehem Inland[1] ... LTV[3] ..... National .. Rouge[4] ... USS[5] .... Weirton .. WP[6]	*	*	*	*	*	*	*	*	*	*	*	*
Total ...	1	8	21	21	21	16	3	(2)	(2)	3	(2)	5

1 * * *
2 * * *
3 * * *
4 * * *
5 * * *
6 * * *

Note.—Figures may not add up to 100 percent because of rounding.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

a galvanizing facility with a capacity of 900,000 tons per year and is scheduled to begin operations in late 1991.[11] LTV currently has two joint ventures with Sumitomo Metals: L-S Electro-Galvanizing Company, which began operations in 1986, and L-S II Electro-Galvanizing Company, which began operations in the spring of 1991.[12] USS division of USX Corp., which has jointly owned and operated a 700,000 ton-per-year electrogalvanizing facility with Rouge Steel in Dearborn, MI since 1986, began construction in early 1991 on the PRO-TEC Coating facility (a joint venture with Kobe Steel) which will produce hot dipped galvanized sheet products.[13] Wheeling- Pittsburgh and Nisshin Steel, which formed a joint venture for hot dip coating in 1988, are planning a second joint venture; the facility is expected to be operational by 1993.1[14] The nature and extent of investment in galvanizing facilities is reflected in table 7-6, which also indicates that nearly 3 million short tons of new production capacity is expected to become operational during 1991-92.

[11] Inland Steel Company, *Form 10-K*, 1990, p. F-12.

[12] The LTV Corporation, *News release*, 90-6s, and The LTV Corporation, *Form 10-K*, 1990, p. 23.

[13] USX, *Annual Report*, 1990, p. 19, and USX Corporation, *Proxy Statement and Prospectus*, 1991, p. VI-6.

[14] Labee and Samways, "Developments," p. D-18.

Foreign Investment in the U.S. Steel Industry

The major integrated steel producers have entered into, or are exploring, joint ventures with foreign firms. Most of the foreign joint venture partners have been Japanese steel companies although several European companies have also been involved. Total foreign investment in joint ventures with the major integrated producers exceeds $3 billion, most of which has been in the galvanizing facilities alluded to above.

With regard to investment by Japanese companies, Kawasaki Steel (a joint venture partner with Armco Inc. in Armco Steel Company, LP) and NKK Corporation (a joint venture partner with National Intergroup in National Steel) increased their equity-shareholdings of Armco and National during 1990.

In addition, Kobe Steel and the USS division of USX Corp. formed a joint venture for hot dipped galvanized sheet product during 1990, referred to above.

Table 7–6
Steel: New domestic sheet coating facilities announced since 1989

Company	*Location (State)*	*Type of facility*	*Annual Cost*	*Start–up Capacity*	*Date*
			Million dollars	*1,000 tons*	
Armco[1]	OH	Electrogalvanizing	116	290	1991
L/S Electro Galvanizing[2]	OH	Electrogalvanizing	200	360	1991
I/N Kote[3]	IN	Electrogalvanizing, Hot dip galvanizing	450	900	1991
Bayamon	PR	Hot dip galvanizing	([4])	120	1991
Bethlehem	IN	Hot dip galvanizing, galvannealing	([5])	450	1992
Bethlehem	MD	Hot dip galvanizing, Galvaluming	([5])	260	1992
Bethlehem	([6])	Hot dip galvanizing, Galvaluming	([5])	260	([7])
NexTech[8]	PA	Hot dip galvanizing	20	100	1990
USS/Kobe[9]	([10])	Hot dip galvanizing, galvannealing	([11])	600	1992
Wheeling–Nisshin	WV	Hot dip galvanizing	120	240	1993

[1] Armco's joint venture with Kawasaki Steel.
[2] LTV's joint venture with Sumitomo Metal Industries.
[3] Inland's joint venture with Nippon Steel.
[4] The cost of this facility remains undisclosed.
[5] The joint cost of Bethlehem's three coating lines is estimated at $300 million.
[6] The exact location of this facility remains undisclosed, although Bethlehem has indicated that it will be located in the South or Southwestern United States.
[7] This facility is estimated to become operational after the start–up of the Maryland facility.
[8] Operated by an investor group led by Metaltech (Pittsburgh, PA) in cooperation with the Regional Industrial Development Corp. of Southwestern Pennsylvania.
[9] US Steel's joint venture with Kobe Steel.
[10] The location of this facility remains undisclosed.
[11] The cost of this facility remains undisclosed.

Source: *Iron and Steel Engineer*, February 1990, February 1991.

With regard to investment by European steelmakers, several joint ventures were formed or were under consideration during 1990. Usinor-Sacilor, a French steelmaking company, expressed an interest in acquiring a minority share in LTV, but the negotiations were not conclusive.[15] In January 1991, Bethlehem and British Steel agreed to conduct a feasibility study on a joint venture for structural and rail products.[16] If the Bethlehem-British Steel joint venture is formed, it would be the second joint venture undertaken by any major integrated company in bar and structural facilities; USS-Kobe was the first such venture.

Restructuring

Temporary Shutdowns

The major integrated steel producers temporarily idled some operations in response to lower demand during 1990-91. For example, Armco announced the temporary layoff of about 1,000 employees at the company's facilities in Ashland and Middletown, Ohio. LTV temporarily laid off workers at its Cleveland Works facility from December 1990 to February 1991 due to low demand. Rouge Steel Company shut down its electric furnaces in December 1990 due to poor business conditions; these furnaces were recently restarted, but their operation is reportedly temporary in nature, intended to cease after the company's blast furnace is relined.

Permanent Shutdowns

Some closures are permanent, due to industry restructuring. For example, Inland has downsized operations at the Indiana Harbor Works, closing a 28-inch structural mill (part of its Bar and Structural division) as well as an underground coal mine near Barnesboro, Pennsylvania. USS intends to permanently close all iron and steel producing operations, the slab and hot strip mill, and the pipe mill facilities at the Fairless, Pennsylvania Works.

Environmental regulations which mandate the reduction of coke-oven emissions are also forcing integrated producers to reconsider certain facilities. LTV has ceased operation of the Cleveland Works No. 1 coking facility. The 145 workers at this facility will reportedly be assigned to other jobs with LTV as they become available.

Marketing and Customer Service

Integrated steel producers are continuing to expand their marketing and customer service efforts. One aspect of such efforts is improved communication with customers due, in part, to electronic data interchange. For example, Weirton has partially completed its company-wide integrated manufacturing information system (IMIS) which, when fully implemented, will allow Weirton customers to ascertain the status of their order quickly and reliably.[17] Other companies have extended warranties on their products; for example, LTV extended its customer satisfaction guarantee, previously provided only on flat rolled products, to prime mechanical tubing and electrical conduit products.[18]

To address another aspect of improving customer service, several companies have restructured their distribution and marketing networks to more-expeditiously accommodate changing market requirements. For example, Inland restructured Joseph T. Ryerson & Son, Inc. and J.M. Tull Metals Company, Inc.,[19] forming 4 regional distribution units. Also, USS formed Department 2000 to sell steel to Japanese automotive transplants based in the United States (Toyota, Honda, Nissan, Mazda, Mitsubishi, and Subaru).[20]

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[15] The LTV Corporation, New release, 90-6.
[16] [* * *].

[17] [* * *] and Weirton Steel Corporation, Annual Report, 1990, pp. 16-18.
[18] The LTV Corporation, *News release*, 90-3s.
[19] Inland Steel Industries, *Annual Report*, 1990, pp. 10-12.
[20] USX, *Annual Report*, pp. 19-21.

APPENDIX A
COPY OF LETTER TO CHAIRMAN ANNE BRUNSDALE FROM AMBASSADOR CARLA HILLS, UNITED STATES TRADE REPRESENTATIVE, REQUESTING AN INVESTIGATION

DOCKET NUMBER

1547

Office of the Secretary Int'l Trade Commission

THE UNITED STATES TRADE REPRESENTATIVE
Executive Office of the President
Washington, D.C. 20506

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RECEIVED

USITC

The Honorable Anne Brunsdale
Chairman
United States International
Trade Commission
500 E Street, S.W.
Washington, D.C. 20436

DOCKET

Dear Madam Chairman:

On July 25, 1989, the President announced the establishment of the Steel Trade Liberalization Program. The program is designed to phase out in a responsible and orderly manner the voluntary restraint arrangements (VRAs) that have limited steel imports into the U.S. market for the past five years, and to negotiate an international consensus to remove unfair trade practices. In order to achieve this goal, the President has directed me to carry out implementation of the program.

To facilitate this policy, I request, pursuant to Section 332(g) of the Tariff Act of 1930, under authority delegated by the President, that the Commission monitor competitive conditions in the steel industry and the industry's efforts to adjust and modernize, including trends and developments in wages and investment, and prepare annual reports on these matters. To the extent possible, the report should include information on the major companies' compensation of executive officers, as well as information from domestic producers and purchasers regarding recent improvements in domestic quality and service, including those that result from industry modernization.

Also, under title VIII of the Trade and Tariff Act of 1984, as amended, the President is required to make an annual determination to the Congress regarding the adjustment efforts of the major steel companies. To assist in this determination, I request the Commission to include in its annual reports the best information it can compile for the preceding 12-month period ending September 30 of 1990 and 1991 on the following matters.

(A) The extent to which the major companies of the steel industry have, or will have committed their net cash flow from steel product operations for purposes of reinvestment in, and modernization of, that industry through investment in modern plant and equipment, research and development, and other appropriate projects, such as working capital or steel operations and programs for the retraining of current and former workers;

(B) Actions taken by the major companies to maintain their international competitiveness, including actions to produce price-competitive and quality-competitive products, and to control costs of production, including employment costs, and to improve productivity; and

(C) Whether each of the major companies committed, or will have committed, not less than one percent of net cash flow to the retraining of current and former workers. This information on retraining should include a comparison of the amounts used to retrain displaced former employees and amounts used for on-the-job retraining within the industry.

If any major company did not commit at least one percent of its net cash flow to the retraining of workers, the Commission should report any unusual economic circumstances which contributed to the company's failure to do so.

For the purpose of this request, the terms "steel industry", "major company", and "net cash flow" shall have the same meaning as that set forth in title VIII of the Trade and Tariff Act of 1984, as amended.

Inasmuch as the President's determination called for in the Act will have to be made before the end of each annual period, the Commission is requested to submit its annual reports by August 1, 1990 and August 1, 1991.

In accordance with USTR policy, I direct you to mark as "confidential" such portions of the Commission's report and its working papers as my Office will identify in a classification guide. Information Security Oversight Office Directive No. 1, section 2001.21 (implementing Executive Order 12356, sections 2.1 and 2.2) requires that classification guides identify or categorize the elements of information that require protection. Accordingly, I request that you provide my Office with an outline of this report as soon as possible. Based on this outline and my Office's knowledge of the information to be covered in the report, a USTR official with original classification authority will provide detailed instructions.

Thank you for your cooperation in this matter.

Sincerely,

Carla

Carla A. Hills

CAH:pjm

APPENDIX B
NOTICE OF THE COMMISSION'S INVESTIGATION

UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, D.C. 20436

Investigation No. 332-289

Steel Industry: Annual Report on Competitive Conditions in the Industry and Industry Efforts to Adjust and Modernize

AGENCY: UNITED STATES INTERNATIONAL TRADE COMMISSION

ACTION: Institution of investigation.

SUMMARY AND BACKGROUND: The Commission instituted the investigation, No. 332-289, under section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332(g)) following receipt on February 28, 1990, of a request from the United States Trade Representative (USTR); the request was made at the direction of the President as part of the implementation of the Steel Trade Liberalization Program which extended voluntary restraint arrangements for a transitional period of two and one-half years to March 31, 1992.

In accordance with the request, the Commission will monitor competitive conditions in the steel industry and the industry's efforts to adjust and modernize, including trends and developments in wages and investment, and prepare annual reports on these matters. To the extent possible, the reports will include information on the major companies' compensation of executive officers, as well as information from domestic producers and purchasers regarding recent improvements in domestic quality and service, including those that result from industry modernization.

Under title VIII of the Trade and Tariff Act of 1984 (19 U.S.C. 2253 note), the President is required to make an annual determination to the Congress regarding the adjustment efforts of the major steel companies. To assist in this determination, the Commission has been requested to include in its annual reports the best information it can compile for the preceding 12-month period ending September 30 of 1990 and 1991 on the following matters.

(A) The extent to which the major companies of the steel industry have, or will have committed their net cash flow from steel product operations for purposes of reinvestment in, and modernization of, that industry through investment in modern plant and equipment, research and development, and other appropriate projects, such as working capital for steel operations and programs for the retraining of current and former workers;

(B) Actions taken by major companies to maintain their international competitiveness, including actions to produce price-competitive and quality-competitive products, and to control costs of production, including employment costs, and to improve productivity; and

(C) Whether each of the major companies committed, or will have committed, not less than one percent of net cash flow to the retraining of current and former workers. This information on retraining should, include a comparison of the amounts used to retrain displaced former employees and amounts used for on-the-job retraining within the industry.

If any major company did not commit at least one percent of its net cash flow to the retraining of workers, the Commission has been asked to report any unusual economic circumstances which contributed to the company's failure to do so.

For the purpose of this investigation, the terms "steel industry", "major company", and "net cash flow" have the same meaning as that set forth in title VIII of the Trade and Tariff Act of 1984.

Inasmuch as the President's determination called for in the Act will have to be made before the end of each annual period, the Commission has been requested to submit its annual reports by August 1, 1990 and August 1, 1991.

EFFECTIVE DATE: March 16, 1990

FOR FURTHER INFORMATION CONTACT: Mr. Mark Paulson, Minerals and Metals Division, United States International Trade Commission, 500 E Street SW., Washington, D.C. 20436 (telephone: 202-252-1432).

WRITTEN SUBMISSIONS: Interested persons are invited to submit written statements concerning the investigation. Commercial or financial information which a submitting party desires the Commission to treat as confidential must be submitted on separate sheets of paper, each clearly marked as "Confidential Business Information" at the top. All submissions requesting confidential treatment must conform with the requirements of section 201.6 of the Commission's Rules of Practice and Procedures (19 CFR 201.6). All written submissions, except for confidential business information, will be made available for inspection by interested persons. To be assured of consideration by the Commission, written statements should be received at the earliest date, but not later than July 1, 1990 and by July 1, 1991. All submissions should be addressed to the Secretary, United States International Trade Commission, 500 E Street SW., Washington, D.C. 20436. Hearing-impaired individuals are advised that information on this matter can be obtained by contacting our TDD terminal on (202) 252-1809.

By order of the Commission.

Kenneth R. Mason
Secretary

Issued: March 16, 1990

APPENDIX C
DEFINITIONS OF CERTAIN TERMS AND PRODUCTS SUBJECT TO THE INVESTIGATION

DEFINITIONS

1. *Firm.*—An individual proprietorship, partnership, joint venture, association, corporation (including all divisions, any subsidiary corporations, and parent corporations), business trust, cooperative, trustees in bankruptcy, or receivers under decree of any court, owning or controlling one or more establishments, as defined below.

2. *Establishment.*—Each plant of a firm in the United States in which carbon and/or alloy steel products (as defined below) are produced and all auxiliary facilities operated in conjunction with (whether or not physically separate from) such production facilities, e.g., warehouses, shipping facilities, and the like.

3. *Steel industry.*—Producers in the United States of steel products.

4. *Capacity.*—For the purposes of the ITC questionnaire, capacity is defined as the greatest level of output a plant can achieve operating within the framework of a realistic work pattern. It takes into consideration downtime for maintenance and excludes facilities that have been inoperative for a long period of time and, therefore, would require extensive reconditioning before being made operative. Capacity assumes, among other things, a normal product mix and an expansion in the number of shifts and hours of plant operation that can be reasonably attained in the plant's locality. This definition is similar to the gross or engineered capacity definition used by PaineWebber, whose figures are cited in chapters 2 and 3.

5. *Net cash flow.*—Annual net (after-tax) income plus depreciation, depletion allowances, amortization, and changes in reserves minus dividends and payments on short-term and long-term debts and liabilities.

6. *United States.*—The 50 states, Puerto Rico, and the District of Columbia.

7. *Steel.*—An alloy of iron and carbon which is malleable as first cast. Steel may contain other elements, but iron must predominate, by weight, over each of the other elements.

8. *Carbon steel.*—Steel in which none of the elements listed below exceeds the quantity, by weight, respectively indicated:

1.65 percent of manganese, or
0.25 percent of phosphorus, or
0.35 percent of sulphur, or
0.60 percent of silicon, or
0.60 percent of copper, or
0.30 percent of aluminum, or
0.20 percent of chromium, or
0.30 percent of cobalt, or
0.35 percent of lead, or
0.50 percent of nickel, or
0.30 percent of tungsten, or
0.10 percent of any other metallic element.

9. *Alloy steel.*—Steel which contains any of the elements listed in definition 7 (above) in excess of its specified quantity.

(i) *Stainless steel.*—Any alloy steel which contains by weight 1.2 percent or less of carbon and 10.5 percent or more of chromium;

(ii) *Tool steel.*—Alloy steel which contains the following combinations of elements in the quantity, by weight, respectively indicated:

(A) more than 1.2 percent carbon and more than 10.5 percent chromium; or

(B) not less than 0.85 percent carbon and 1.0 percent to 1.8 percent, inclusive, manganese; or

(C) 0.9 percent to 1.2 percent, inclusive, chromium and 0.9 percent to 1.4 percent, inclusive, molybdenum; or

(D) not less than 0.5 percent carbon and not less than 3.5 percent molybdenum; or

(E) not less than 0.5 percent carbon and not less than 5.5 percent tungsten; or

(F) not less than 0.3 percent carbon and 1.25 percent or more but less than 10.5 percent chromium.

(iii) *Certain alloy steel.*—Alloy steel not covered under 8.(i) "Stainless steel" or 8. (ii) "Tool Steel."

10. *Galvanized.*—Steel which has been coated or plated with zinc.

11. *Hot-rolled.*—Steel which has been reduced to its final thickness by heating and rolling at elevated temperature (usually above 2,200° F).

12. *Cold rolled.*—Steel which has been reduced to its final thickness by rolling the product without heating it immediately prior to the rolling operation.

13. *Continuous casting.*—The method of producing semifinished products in which molten steel flows evenly into a caster where it is rapidly cooled, causing it to solidify directly into semifinished products such as slabs and billets.

14. *Short ton.*—2,000 pounds.

15. *Metric ton.*—2,204.6 pounds.

16. *Semifinished products* include.—Continuous cast products of solid section, not presented in coils, whether or not subjected to primary hot-rolling—other products of solid section which have not been further worked than subjected to primary hot-rolling or roughly shaped by forging, including blanks for angles, shapes, or sections.

Ingots.—Castings resulting from the solidification of molten steel and having a columnar form suitable for working by rolling or forging. Ingots are included in AISI (American Iron and Steel Institute) product group No. 1A.

Blooms, billets, slabs, and sheet bars.—Other products of solid cross section, which have not been further worked than subjected to primary hot-rolling or roughly shaped by forging including blanks for angles, shapes or sections. These products are not presented in coils and are included in AISI product group No. 1B.

For the purpose of this report, flat rolled products are classified as follows:

17. *Flat-rolled products.*—Rolled products of solid rectangular (other than square) cross section, whether perforated, corrugated, polished, or with a pattern derived from rolling, which do not conform to the definition of semifinished products above in the form of:

- coils of successively superimposed layers, or
- straight lengths, which if of a thickness less than 0.187 inch (4.75 mm) are of a width measuring at least 10 times the thickness or if of a thickness of 0.187 inch (4.75 mm) or more are of a width which exceeds 5.9 inches (150 mm) and measures at least twice the thickness. Also those products of a shape other than rectangular, or, square of a width of 23.6 inches (600 mm) or more, not elsewhere specified.

(i) *Plates.*—Flat-rolled products whether or not corrugated or crimped, in coils or cut to length. Plates are 0.188 inch (4.7625mm) or more in thickness and, if not cold rolled, over 8 inches (20.32 cm) in width, or if cold rolled, over 12 inches (30.45 cm) in width. Plates are included in AISI product group No. 6.

(ii) *Sheets and strip.*—Flat-rolled products whether or not corrugated or crimped, in coils or cut to length. Sheet is less than 0.188 inch (4.7625 mm) in thickness and over 12 inches (30.48 cm) in width. Strip is less than 0.188 inch (4.7625 mm) in thickness, not over 12 inches (30.48 cm) in width and, if cold-rolled, over 0.5 inch (1.27 cm) in width. Sheets and strip are included in AISI product group Nos. 28, 29, 29A, 30, 31, 32, 33A, 33B, 34, 34B, 35, 36, and 37.

18. *Bars.*— Hot-rolled products whether or not in irregularly wound coils, which have a solid cross section along their length in the shape of circles, segments of circles, ovals, rectangles (including squares), triangles, or other convex polygons. Such products may:

- have indentations, rubs, grooves or other deformations produced during the rolling process (reinforcing bars and rods);
- be twisted after rolling.

For purposes of this investigation the term "bars" also includes hollow drill steel, which is a hollow product suitable for making mining drills or mining drill rods, of which the greatest external dimension of the cross-section exceeds 0.6 inch (15 mm) but does not exceed one-half of the greatest external dimension. Bars and hollow drill steel are found in AISI product groups Nos. 14, 14A, 15, and 16.

For the purposes of this investigation, bars and light structural shapes are classified as follows:

(i) *Hot-rolled bars*, including light structural shapes (which are bar-size light shapes having a cross-sectional dimension of less than 3 inches (7.62 cm) included in AISI product group 14A) and reinforcing bars. Hot rolled carbon and alloy bars are included in AISI product group Nos. 14 and 15.

(ii) *Cold-formed bars*, included in AISI product group No. 16.

19. *Wire rods*.—Coiled, semifinished, hot-rolled products of solid cross section, approximately round in cross section, not under 0.5 inch (14 mm) nor over 0.75 inch (19 mm) in diameter. Wire rods are included in AISI product group No. 3.

20. *Wire and wire products*

(i) Wire includes cold-formed products in coils, of any uniform solid cross section along their whole length, which do not conform to the definition of flat-rolled products. Steel wire is included in AISI product group No. 23.

(ii) Wire products are defined as follows:

(A) *Nails and brads, spikes, staples, and tacks* are fasteners of one piece construction, made of round wire, and not including thumb tacks, staples in strip form, corrugated fasteners, glaziers' points, hook nails, ring nails, or fasteners suitable for use in power-actuated hand tools. Nails and staples are included in AISI product group No. 51.

(B) *Barbed wire* is a wire, or strand of twisted wires, armed with barbs or sharp points. Barbed wire is included in AISI product group No. 52.

C) *Wire expanded metal, grill and fencing* include products, whether or not galvanized, wholly of round wire with a maximum cross-sectional diameter of 0.12 inch (3 mm) or more, having a mesh size of 39.4 cubic inches (100 cm3) or more, whether or not such wire is covered with plastics. The products are included in AISI product group No. 50.

(D) *Baling wire and ties*, with or without buckles or fastenings and whether or not coated with paint or other substance and included in AISI product group No. 53.

(E) *Wire strand* is two or more wires which together constitute one of the parts which are twisted together to form rope, cord, or cordage, suitable for fencing purposes, not fitted with fittings, not made up into articles, not of brass plated wire, not covered with nonmetallic material. Wire strand is included in AISI product group No. 45.

(F) *Wire ropes, cables, and cordage* are products made by the twisting of a number of wire strands and are not covered with nonmetallic material, not fitted with fittings, not made up into articles, and, if valued 13 cents or more per pound, not of brass plated wire. Wire ropes, cables, and cordage are included in AISI product group No. 47.

(G) *Milliners wire* is wire covered with textile or other material not wholly of metal. Milliners wire is included in AISI product group No. 23(pt.).

21. *Structurals*.—Rolled flanged sections, sections welded from plates and special sections including beams, channels, tees, zees and angles with a cross section of 3 inches or more.

(i) *Heavy structural shapes* having a maximum cross-sectional dimension of 3 inches (7.62 cm) or more, and sheet piling. These products are included in AISI product group No. 4.

(ii) *Fabricated structural units*, which include columns, pillars, posts, beams, girders, and similar structural units. These products are included in AISI product group Nos. 38 and 39.

22. *Rails and related railway products* as defined by the following:

(i) *Rails* are hot-rolled steel products, whether punched or not punched, weighing not less than 8 pounds per yard, with cross-sectional shapes intended for carrying wheel loads in railroad, railway, and crane runway applications. Rails are included in AISI product group Nos. 7, 8 and 41.

(ii) *Joint bars* are hot-rolled steel products, usually punched or slotted, designed to connect the ends of adjacent rails in track; tie plates are hot-rolled steel products which are punched to provide holes for spikes and have one or two shoulder sections as rail guides and are used to support rails in track, to maintain track gauge, and protect the ties. Joint bars and tie plates are included in AISI product group Nos. 9 and 42 (pt.).

(iii) *Railway track spikes*, of one piece construction, used to secure tie plates or ties. Railway track spikes are included in AISI product group No. 42 (pt.).

(iv) *Railroad and railway (RR) axles and wheels, parts thereof, and axle bars*. These articles are included in AISI product group No. 43.

23. *Pipes and tubes and blanks therefor.*—Tubular products, including hollow bars and hollow billets but not including hollow drill steel, of any cross-sectional configuration, by whatever process made, whether seamless, brazed, or welded and whether with an open or lock seam or joint. For the purposes of this investigation, pipes and tubes and blanks therefor are classified as follows:

(i) *Oil country tubular goods*. Oil country tubular goods are included in AISI product group No. 19.

(ii) *Line pipe*. Line pipe is included in AISI product group No. 20.

(iii) *Mechanical pipe*. Mechanical pipe is included in AISI product group No. 21A.

(iv) *Structural pipe*. Structural pipe is included in AISI product group No. 22.

(v) *Pressure tubing*. Pressure tubing is included in AISI product group No. 21B.

(vi) *Stainless steel pipes and tubes*. Stainless steel pipes and tubes are included in AISI product group Nos. 21C and D.

(vii) *Other, including standard*. Other, including standard pipe, is included in AISI product group No. 18.

APPENDIX D
GLOSSARY OF TECHNICAL TERMS

ABBREVIATIONS, COINED WORDS, AND COINED SYMBOLS

BOF (BOP)	Basic oxygen furnace (process)
CC	Continuous casting
DRI	Direct reduced iron
EAF	Eectric arc furnace
MES	Minimum efficient scale
VRAs	Voluntary restraint agreements

TERMS

Alloys
Metallic substances added to steel to enhance properties such as machinability or heat resistance.

Annealing
A process by which, through controlled heating and cooling, ductility (or formability) is restored to steel.

Bar
A shaped steel product available in many configurations, including rounds, squares, ovals, hexagons, and rectangles.

Basic oxygen furnace (process)
A steelmaking process that involves blowing high-purity oxygen onto the surface of a bath of molten pig iron. The dominant steelmaking process in the United States since the 1970s.

Beam blanks
Special shapes that are subsequently rolled into structural shapes, mainly I-beams.

Benefication
All the methods used to process iron ore to improve its chemical or physical characteristics in ways that will make it a more desirable feed for the ironmaking furnace.

Billet
A square or rectangular semi-finished piece of steel that is later rolled into a finished product, such as a bar.

Bloom
A square or rectangular semi-finished piece of steel (larger than a billet) that is later rolled into a finished product, such as an I-beam or other shape.

Blowing
Forcing air, oxygen, or other gases through molten metal for the purpose of refinement.

Brownfield
A facility built on the site of some previously existing infrastructures, buildings, or equipment. Contrasts with greenfield.

Coke
Material used in blast furnaces, formed by baking coal in the absence of air.

Cold-rolled/cold-formed products
Flat-rolled products which are not heated immediately prior to rolling/forming. Cold reduction results in a product that is thinner, smoother, and has a higher strength to weight ratio.

Commercial quality steel sheet
Sheet designed for uses involving simple bending or moderate drawing. Commercial quality sheet can be expected to show wide variations in mechanical and chemical properties.

Continuous caster
A machine which converts a heat of molten steel to semi-finished shapes. The continuous casting process is more efficient and generally yields a higher quality product compared to the traditional ingot casting method.

Direct reduced iron (DRI)
Ore, usually in the shape of briquettes, that has gone through a reduction process that has driven off most of the oxygen so that the briquettes contain up to 97 percent natural iron. DRI is iron-rich enough to be used as a metallic charge in electric furnace steelmaking.

Drawing quality steel sheet
Sheet which is more ductile and uniform in chemical composition than commercial quality sheet. Drawing quality sheet is produced from specially selected steel, which is carefully processed to result in more uniform drawing properties,

Electric arc furnace (EAF)
A device that passes a strong electric current through steel scrap, thereby melting it (because of scrap's high resistance) and allowing it to be cast into steel shapes. Minimills and specialty mills use EAFs, as do many integrated mills.

Electrogalvanizing
The process of applying zinc to a steel substrate by passing an electrically charged steel product though an oppositely charged, zinc-rich electrolytic solution. Contrasts with hot-dip galvanizing.

Flat-rolled steel products
Steel produced on rolls with smooth faces in contrast to the cut or grooved roll faces employed in the manufacture of shapes. There are two major types of flat-rolled steel products: hot rolled and cold rolled.

Galvanize
To apply a zinc coating to a steel substrate. Used for applications where corrosion resistance is required.

Galvalume
A coated steel product utilizing an aluminum/zinc/silicon (55 percent/43.5 percent/ 1.5 percent) alloy coating. Corrosion resistance is superior to 100 percent pure zinc galvanizing, especially at higher temperatures.

Galfan
A zinc/aluminum/mischmetal (95 percent/5 percent/trace) alloy coating. Galfan is highly ductile and resists cracking and flaking when the steel substrate is formed.

Gauge
A measure of material thickness.

Greenfield
A facility built on an entirely new site. Contrasts with brownfield.

Heat
A batch of steel melted at one time.

Hot end
The melting, refining, and casting facilities of a steel mill.

Hot-dipped galvanizing
Process whereby prepared steel is dipped beneath a surface of molten zinc. Contrasts with electrogalvanizing.

I-beams
Structural steel product shaped like the letter "I". Used in the construction of bridges, buildings, ships, and other construction purposes.

Iron
A common mineral found in the earth's surface in the form of iron ore mixed with rock, earth, or sand.

Ingot
A large steel shape, formed when molten steel is poured (teemed) into an ingot mold to solidify. The ingot is later reheated and rolled into a semi-finished steel shape such as a billet, bloom, or slab.

Integrated mills
Mills that typically include all six steps of steelmaking: ore processing, cokemaking, ironmaking, steelmaking, rolling, and treating. Generally substantially larger than specialty or minimills.

Ladle metallurgy
The practice of further steel refinement, performed in a ladle after partial refining of a heat in a steelmaking furnace.

Lance
Water-cooled, copper-tipped, and retractable oxygen-jet equipment used to blow oxygen into the top, or increasingly, bottom and side, of the BOF.

Long products
Steel products that are not flat-rolled.

Minimills
Mills that usually bypass the first three steps of steelmaking (ore processing, cokemaking, and ironmaking) and use scrap as the primary raw material in electric arc furnaces. Minimills account for a growing share of U.S. steel production.

Near-net shape casting
Process of casting steel into a semifinished form that requires only minimal physical alteration to produce finished products. An example is thin slab casting.

Open-hearth furnace
A reverbaratory, regenerative steelmaking furnace that has largely been replaced by the BOF. The dominant process of steelmaking in the United States until the 1970s.

Pickle
To remove oxide deposits on the surface of a steel product by immersing it in acidic baths.

Pig iron
A metallic product of the blast furnace that is generally not usefully malleable. Contains over 90 percent iron and over 2 percent carbon.

Rationalization
Company efforts to improve their competitive position, usually in response to imbalances between capacity and production and poor financial performance. Rationalization typically includes sizable workforce reductions, plant closure, and modernization of remaining facilities.

Reconstituted mill
Facilities spun off from a major producer or reorganized in a way that has reduced input and capital costs. Involves substantial modification of original producer's financial structure, usually through bankruptcy or the sale of facilities to new owners.

Rolling mill
Equipment that reduces and transforms the shape of semifinished or intermediate steel products by passing the material though a gap between rolls that is smaller than the entering material.

Scale
Waste that collects on the surface of steel during the steelmaking process.

Secondary steelmaking
See "Ladle metallurgy."

Semifinished steel
Steel shapes such as billets, blooms, or slabs that are later rolled into finished products.

Slab
A semifinished form of steel, rectangular in shape, with a width at least twice the thickness. Slabs can either be rolled from ingots or cast directly on a continuous casting machine.

Sheet
A flat-rolled finished steel product. Sheet is wider (12 inches or more in width) and produced to less exact thicknesses than strip, a similar flat-rolled product.

Specialty steel
Steel, such as stainless, heat resisting, and tool steel, produced in small volumes to meet specialized needs.

Strip
A flat-rolled steel product. Strip is narrower (12 inches or less in width) than sheet and produced to more closely controlled thicknesses.

Structural shapes
Rolled flanged shapes having at least one dimension of their cross-section 76 mm or greater. Used mainly for construction purposes.

Tolerance
The permissible range of dimensions of a finished steel product.

Tool steel
Specialty steel that can be hardened and tempered for use in making tools and dies.

APPENDIX E
EXPORTS TO THE UNITED STATES OF STEEL PRODUCTS SUBJECT TO VOLUNTARY RESTRAINT AGREEMENTS

Table E-1
Steel products subject to voluntary restraint agreements (VRAs): Exports to the United States, by VRA country or region, and export ceilings, October 1984 through December 1985

Country[1]	*Actual exports*	*Final 15-month export ceiling*	*Percent of export ceiling filled*	*Tonnage exceeding limits*
	Metric tons		*Percent*	*Metric tons*
Australia	181,918	190,623	95.4	-8,705
Brazil	1,760,482	1,806,681	97.4	-46,199
Czechoslovakia	44,418	44,418	100.0	0
East Germany	136,080	137,981	98.6	-1,901
EC-10[2]	4,403,871	4,401,534	100.1	2,337
Finland	252,826	254,752	99.2	-1,926
Hungary	28,626	62,370	45.9	-33,744
Japan	6,711,886	6,218,545	107.9	493,341
Korea	2,196,426	2,129,460	103.1	66,966
Mexico	367,161	476,417	77.1	-109,256
Poland	112,863	102,060	110.6	10,803
Portugal	145,648	118,842	122.6	26,806
Romania	329,027	326,590	100.7	2,437
Spain	693,265	693,938	99.9	-673
South Africa	531,821	554,654	95.9	-22,833
Venezuela	373,262	416,431	89.6	-43,169
Yugoslavia	84,280	62,763	134.3	21,517
Total	18,353,860	17,998,059	102.0	355,801

[1] No agreement was in place in this time period for Austria, the People's Republic of China, and Trinidad and Tobago.
[2] Excludes Spain and Portugal.
Source: U.S. Department of Commerce, Office of Agreements Compliance.

Table E-2
Steel products subject to voluntary restraint agreements (VRAs): Exports to the United States, by VRA country or region, and export ceilings, 1986

Country[1]	*Actual exports*	*Final 1986 export ceiling*	*Percent of export ceiling filled*	*Tonnage exceeding limits*
	Metric tons		*Percent*	*Metric tons*
Australia	203,595	208,993	97.42	-5,398
Austria	121,431	120,284	100.95	1,147
Brazil	1,183,446	1,238,947	95.52	-55,501
Czechoslovakia	32,615	37,014	88.12	-4,399
East Germany	83,411	83,927	99.39	-516
EC-10[2]	4,837,051	4,713,349	102.62	123,702
Finland	178,490	173,057	103.14	5,433
Hungary	20,954	30,845	67.93	-9,891
Japan	3,837,715	4,046,011	94.85	-208,296
Korea	1,445,928	1,401,403	103.18	44,525
Mexico	335,076	342,850	97.73	-7,774
Poland	61,773	71,905	85.91	-10,132
Portugal	18,406	18,571	99.11	-165
Romania	81,273	84,372	96.33	-3,099
Spain	543,244	582,203	93.31	-38,959
Venezuela	141,580	158,914	89.09	-17,334
Yugoslavia	13,316	13,295	100.16	21
Total	13,139,304	13,325,940	98.60	-186,636

[1] No agreement was in place at this time for the People's Republic of China and Trinidad and Tobago.
[2] Excludes Spain and Portugal.
Source: U.S. Department of Commerce, Office of Agreements Compliance.

Table E-3
Steel products subject to voluntary restraint agreements (VRAs): Exports to the United States, by VRA country or region, and export ceilings, 1987

Country	Actual exports	Final 1987 export ceiling	Percent of export ceiling filled	Tonnage exceeding limits
	Metric tons		Percent	Metric tons
Australia	204,955	217,399	94.28	-12,444
Austria	123,341	160,031	77.07	-36,690
Brazil	1,314,650	1,256,036	104.67	58,614
Czechoslovakia	37,400	37,875	98.75	-475
East Germany	93,490	98,796	94.63	-5,306
EC-10[1]	4,685,700	4,780,998	98.01	-95,298
Finland	167,308	171,997	97.27	-4,689
Hungary	30,257	30,845	98.09	-588
Japan	4,167,471	4,757,619	87.60	-590,148
Korea	1,445,030	1,463,808	98.72	-18,778
Mexico	311,986	358,962	86.91	-46,976
People's Republic of China	56,714	61,689	91.94	-4,975
Poland	93,144	93,338	99.79	-194
Portugal	30,718	31,613	97.19	-895
Romania	97,397	107,411	90.68	-10,014
Spain	477,433	579,042	82.45	-101,609
Trinidad & Tobago	73,585	59,866	122.92	13,719
Venezuela	225,718	240,679	93.78	-14,961
Yugoslavia	10,979	10,141	108.26	838
Total	13,647,276	14,518,145	94.00	-870,869

[1] Excludes Spain and Portugal.
Source: U.S. Department of Commerce, Office of Agreements Compliance.

Table E-4
Steel products subject to voluntary restraint agreements (VRAs): Exports to the United States, by VRA country or region, and export ceilings, 1988

Country	Final Actual exports	1988 export ceiling	Percent of export ceiling filled	Tonnage exceeding limits
	Metric tons		Percent	Metric tons
Australia	229,854	242,764	94.68	-12,910
Austria	119,958	221,186	54.23	-101,228
Brazil	1,138,533	1,238,507	91.93	-99,974
Czechoslovakia	26,741	35,777	74.74	-9,036
East Germany	86,704	98,472	88.05	-11,768
EC-10[1]	4,770,649	5,673,758	84.08	-903,109
Finland	190,385	223,348	85.24	-32,963
Hungary	30,481	30,845	98.82	-364
Japan	4,124,771	5,722,082	72.09	-1,597,311
Korea	1,359,248	1,760,326	77.22	-401,078
Mexico	372,847	451,123	82.65	-78,276
People's Republic of China	63,300	70,293	90.05	-6,993
Poland	73,153	77,411	94.50	-4,258
Portugal	15,115	26,564	56.90	-11,449
Romania	81,768	99,783	81.95	-18,015
Spain	498,811	691,736	72.11	-192,925
Trinidad & Tobago	34,685	39,486	87.84	-4,801
Venezuela	127,851	195,145	65.52	-67,294
Yugoslavia	12,574	18,140	69.32	-5,566
Total	13,357,428	16,916,746	78.96	-3,559,318

[1] Excludes Spain and Portugal.
Source: U.S. Department of Commerce, Office of Agreements Compliance.

Table E-5
Steel products subject to voluntary restraint agreements (VRAs): Exports to the United States, by VRA country or region, and export ceilings, January 1989 through September 1989

Country	Actual exports	Final 1989 export ceiling	Percent of export ceiling filled	Tonnage exceeding limits
	Metric tons		Percent	Metric tons
Australia	143,372	171,774	83.47	-28,402
Austria	68,383	154,384	44.29	-86,001
Brazil	863,721	1,008,569	85.64	-144,848
Czechoslovakia	17,644	28,231	62.50	-10,587
East Germany	35,237	74,845	47.08	-39,608
European Community[1]	3,018,777	4,382,688	68.88	-1,363,911
Finland	110,301	162,086	68.05	-51,785
Hungary	21,544	23,133	93.13	-1,589
Japan	2,604,827	4,148,053	62.80	-1,543,226
Korea	783,176	1,311,290	59.73	-528,114
Mexico	298,401	456,153	65.42	-157,752
People's Republic of China	41,398	55,205	74.99	-13,807
Poland	54,885	62,627	87.64	-7,742
Romania	42,268	69,334	60.96	-27,066
Trinidad & Tobago	36,584	39,901	91.69	-3,317
Venezuela	134,776	154,351	87.32	-19,575
Yugoslavia	6,719	16,421	40.92	-9,702
Total	8,282,013	12,319,045	67.23	-4,037,032

[1] Includes Spain and Portugal.

Source: U.S. Department of Commerce, Office of Agreements Compliance.

Table E-6
Steel products subject to voluntary restraint agreements (VRAs): Exports to the United States, by VRA country or region, and export ceilings, October 1989 through December 1990

Country	Actual exports	Adjusted export ceiling	Percent of export ceiling filled	Tonnage exceeding limits
	Metric tons		Percent	Metric tons
Australia[1]	326,313	425,291	85.19	-62,978
Austria	178,319	278,304	64.07	-99,985
Brazil[1]	1,916,917	2,185,765	87.70	-268,848
Czechoslovakia	15,978	41,875	38.16	-25,897
East Germany	43,783	112,500	38.92	-68,717
European Community[2]	5,714,499	7,601,802	75.17	-1,887,303
Finland[1]	266,471	281,035	94.82	-14,564
Hungary	38,549	50,000	77.10	-11,451
Japan	3,789,353	5,464,729	69.34	-1,675,376
Korea	1,820,990	2,528,694	72.01	-707,704
Mexico[1]	687,126	1,062,282	64.68	-375,156
People's Republic of China[1]	75,193	89,737	83.79	-14,544
Poland	78,654	143,750	54.72	-65,096
Romania	71,935	120,000	59.95	-48,065
Trinidad & Tobago[1]	74,544	127,009	58.69	-52,465
Venezuela	252,161	369,097	68.32	-116,936
Yugoslavia	33,805	50,000	67.61	-16,195
Total[1]	15,420,590	20,931,870	73.67	-5,511,280

[1] Preliminary.
[2] Includes Spain and Portugal.

Source: U.S. Department of Commerce, Office of Agreements Compliance.

APPENDIX F
DESCRIPTION OF STEELMAKING TECHNOLOGY

FACTORS AFFECTING THE ADOPTION OF TECHNOLOGY

The barriers to modernization for many steelmakers is less limited by the availability of technology than by the means with which to acquire equipment.[1] A number of factors influence the adoption decision, including the nature and remaining economic life of existing installed technology, the availability of investment funds, the availability and relative cost of steelmaking factors of production (labor, energy, and raw materials), and market orientation.

The nature of existing technology possessed by a firm may also influence its decision concerning the adoption of new or different technology. Certain equipment may not complement existing equipment, therefore reducing the advantages of adoption.

Steelmaking equipment generally has a long life, and replacement decisions in a profit-maximizing atmosphere must consider economic performance, as opposed to mere technical superiority. Because of the large financial costs of many steelmaking processes, it can be economically justifiable to defer the adoption of new technology that offers operating cost savings. There are numerous examples of facilities that use older technology that have been highly profitable, at least in the short run, and technologically advanced firms that experienced economic difficulties because of financing costs related to the acquisition of modern plant and equipment.

The financial resources of a firm, and therefore the amount available for capital investment, are limited. Investment capital is therefore divided among different needs and projects.

Additionally, various producers and national industries face different absolute and relative raw materials costs. Technology which offers a net reduction or trade-off in raw material or energy consumption may yield significant cost advantages to one producer but only minimal savings to another. For some technological advancements, large disparities in adoption rates between different countries may be economically justifiable for all countries involved.

Finally, customers have different requirements and expectations for the steel products they purchase. A significant portion of the overall steel market is for commercial grade products. Such products can typically be produced on equipment that is far from the cutting edge. Certain technologies are therefore inappropriate candidates for adoption by some firms. Because of this, and the complexity introduced by a variety of input options, the linkage between technological superiority and economic competitiveness is somewhat ambiguous. Those firms that compete in markets for high quality steel products need to acquire technology that is both cost-saving and quality-enhancing. These firms need to be technically advanced in many ways in order to compete. But for some firms, minimal levels of quality are acceptable to their customer base. While these companies must pursue cost reducing technology, they need not pursue the boundaries of quality-enhancing technology in order to compete effectively in their markets.

PRIMARY PROCESS STEPS

Cokemaking

Coke is the primary blast furnace fuel, produced by baking coal at high temperatures, driving off volatile elements and resulting in a product that is virtually pure carbon. Virtually all coke is produced using the by-product coking process, in which chemicals driven off in the baking are reclaimed. By-product coke ovens operate at greater than atmospheric pressure and are susceptible to gas leaks. These by-product recovery plants consume and contaminate large amounts of process water, which must be treated. The expenditures required to control the air and water pollution from this process have raised construction costs for new ovens to relatively high levels in most developed countries. As a result, few coke ovens have been built in recent years and coking capacity has declined significantly.

Some companies are pursuing a different coke-making technology that produces heat as its only by-product and operates at less than atmospheric pressure. Only simple pollution control technology is required to scrub sulfur and particulates from exhaust gases, and costs are far less

[1] Equipment manufacturers have either developed or licensed virtually all major steelmaking technologies. State-of-the-art or near state-of-the-art machinery for all process steps can generally be freely purchased.

onerous than for by-product coking. In some cases the heat is merely expelled (non-recovery cokemaking), while in other cases it is used to generate of electricity (heat recovery cokemaking).

Ironmaking

The blast furnace is the primary method of producing molten iron for open heath or basic oxygen steelmaking. Using iron ore, coke, lime and hot air as raw materials, the blast furnace separates the iron from waste products. The efficiency of blast furnaces (when run at high operating levels) increases significantly with size and has contributed to the large scale requirements for economic production using the integrated process.

As coke availability has declined and costs have risen, steelmakers have begun to pursue the direct use of coal in ironmaking, a step that offers benefits in energy use, furnace productivity, and overall costs.[2] One popular method involves injecting coal dust with the hot air blast, which decreases coke consumption. However, coal injection has limits, and it is estimated that injected coal can at best replace only 40 percent of current coke usage.

Another established approach to ironmaking is direct reduction. Although several processes have been developed, the most successful designs are fired by natural gas and have generally proven economic only in regions with low natural gas costs. Direct reduction produces iron in a solid form, well suited to electric furnace operations but less useful for basic oxygen steelmaking.[3]

The desire to find alternatives to coke-based ironmaking has spawned several processes which use coal directly, generally referred to as "smelting-reduction (SR)" processes. The most advanced SR ironmaking process, called Corex, has operated successfully on a commercial basis since November, 1989. Corex provides a smaller scale ironmaking process and reverses the trend toward increasingly larger vessels for ironmaking.[4]

[2] F. Fitzgerald, presentation made at "Steel Survival Strategies V" symposium, June 26, 1990.

[3] DRI is sometimes used as a coolant in BOF operations. BOFs must have molten iron to operate.

[4] This size reactor produces slightly less than 1000 tons per day. The most efficient blast furnaces produce approximately 10,000 tons per day.

This process offers potential advantages to both the integrated and minimill sectors. For integrated mills, Corex offers convenient complementary capacity for ironmaking, providing technology that can be turned on and off more easily than blast furnaces. For minimills, it offers a hot metal source at low cost and in small quantities. This iron can be used to dilute contaminated scrap. However, the technology would have to be scaled up, to perhaps 700,000 tons per year, in order to conform with existing technology in integrated facilities.

Although several smelting/reduction research programs for ironmaking exist, and Corex technology is a proven performer for ironmaking via the SR route, research continues. A single steelmaking reactor, combining the smelting functions of the blast furnace and the reduction processes of a steelmaking furnace, has long been a goal of steel researchers. A current project, involving the U.S. and Canadian industries, the U.S. government, and various universities may finally attain this goal. Aimed at developing a technology suited to using North American coal, this project studies technologies that would allow steel production from ore without the use of coke oven or blast furnace facilities. Success of this technology would allow replacement of coke ovens, and blast and basic oxygen furnaces with a one step process.

Oxygen Steelmaking

By the beginning of the 1970s, the basic oxygen furnace (BOF) had firmly supplanted the open hearth furnace as the primary route for bulk steel production. In its original form, a BOF facility consisted of a refractory vessel and an oxygen lance, which was inserted into the vessel's top.[5] As oxygen steelmaking tech- nology improved, systems for injecting oxygen into the side and bottom of the vessel were developed. Such systems, alone or combined with top blowing, resulted in improved stirring and homogeneity of the bath. When a standard BOF is retro-fitted with combined blowing technology, improvements in the metallurgical quality of the steel

[5] The principle of oxygen steelmaking rests on the exothermic reaction of carbon and oxygen at elevated temperatures. Oxygen blown through the bath removes the carbon from the steel and generates heat as well.

(lower carbon, oxygen, sulfur, phosphorus, and nitrogen levels) are attained, as well as a concomitant decrease in operating costs.[6]

Electric Arc Furnace

Electric arc furnace (EAF) technology is relatively old, but its use has increased greatly since the early 1970s, especially in the United States. Since that time, it has undergone numerous modifications to improve efficiency and productivity. These improvements led to increased capacity and productivity, with typical cycle times cut from 2 hours in 1960 to 70-80 minutes at present.[7] While some of this decrease is due to the increasingly common practice of finishing the refinement phase in a ladle (see below), most of it is due to improved furnace technology.

Ladle Metallurgy

The term "ladle metallurgy" covers a variety of processes, including vacuum degassing, molten steel treatment, and reheating. These processes are all performed in a ladle used to transfer steel from the furnace to the casting bay. In ladle-refining practice, some of the refining functions formerly achieved in the steelmaking furnace, such as decarburization or adjustments to temperature and chemical composition, are performed in the ladle itself. Ladle metallurgy permits production of higher quality steels and reduces ferroalloy requirements.[8] Ladle refining is estimated to decrease the cost of refining steel by about $27 per ton.[9] When using the ladle for the final refining steps, productivity benefits are realized as higher utilization rates and improved operating practices are achieved for furnaces and casters. Ladle metallurgy has become increasingly important for both cost containment and quality improvement over the last 20 years.

[6] B.L. Farrand and T. Wyatt, "Metallurgical and Operating Performance of the KOBM Process at Dofasco," *Iron and Steel Engineer*, November 1990, p. 52.

[7] W. Huskonen, "EAF Progress Round-up," *33 Metal Producing*, December 1988, p. 27.

[8] Masami Sato, "Recent Trends of Technological Development in the Japanese Steel Industry," address at Japan Steel Information Center Seminar, Washington, D.C., Apr. 25, 1991.

[9] The Electric Power Research Institute, cited in R. Brooks, "Optimizing the EAF," *33 Metal Producing*, October 1989, p. 24.

Continuous Casting

Continuous casting is a process that produces semifinished shapes, such as billets, blooms, and slabs, directly from molten steel. Previous technology involved casting ingots which were then rolled into semifinished shapes. The core of a continuous casting machine is a water cooled mold which is open at both ends. Molten steel enters one end of the mold and is cooled, forming a skin of metal around a liquid core. The metal then exits the other end of the machine and is cooled by water sprays, solidifying the metal to the core. At regular intervals, sections of the cast strand are cut off, forming the semifinished product.

Continuous casting has contributed to the most significant changes in steel industry structure in the last twenty years. This technology offers both capital and operating cost savings, improved productivity and yield, and higher product quality. The application of continuous casting results in average operating cost savings of $20 to $30 per ton compared to ingot casting.[10] Continuous casting (in conjunction with the electric arc furnace) also contributed significantly to lowering the minimum efficient scale of steelmaking and the barriers to industry entry.

Continuous casting technology is also moving toward casting closer to the final shape of the product. Net shape or near net shape casting reduces succeeding processing requirements, reducing both capital and operating costs. Most of the development in such technology has been for casting beam blanks, thin slabs, and strip.

Beam blanks are semifinished products intended to be rolled into structural shapes, such as wide flange beams and H columns. Beam blanks are cast with a modest I-shaped cross section and therefore require less processing to achieve final dimensions. Beam blank casters have been commercialized for some time, but development continues and recent machines cast closer to final shape than earlier models.

Thin slab casters[11] have been recently tested in a commercial setting at Nucor's Crawfordsville, IN facility. This facility is reported to have a cost advantage over traditional sheet facilities of

[10] PaineWeber, World Steel Dynamics, *Steel Strategist #17*, February 1991, p. 101.

[11] Thin slabs are usually about 2 inches thick.

$30 per ton for pickled and oiled hot-rolled band and $56 per ton for cold-rolled sheet.[12] Thin slab casting is currently limited as to the qualities of products it can produce, and opinion is divided over the eventual capabilities of the technology.

In the area of strip casting, partial success has been attained although testing continues. Allegheny-Ludlum's (Pittsburgh, Pennsylvania) experiments with a single wheel caster have proven successful for certain grades of stainless steel. Allegheny Ludlum (AL) and Voest-Alpine Industrieanlagenbau (VAI) are currently building a commercial scale machine in the United States. Trade marked "Coilcast", the machine will be built by VAI and operated by AL.[13]

Hot Rolling

Hot rolling transforms semifinished products into their final, or near final, shape. It is referred to as "hot" rolling because the material is heated before entering the rolling mill. The material makes repeated passes through pairs of rolls which squeeze the steel incrementally closer to its finished shape. Most steel products undergo no further rolling operations during their manufacture. Cold rolled sheet products are the primary exception.

The main improvements in rolling mill technology, for hot as well as cold rolling, have been in control technology and the rolls themselves. Control technology has moved from an analog/mechanical approach to a digital/hydraulic approach, yielding significant improvements in performance. New developments in the design of rolls, especially those for rolling sheet products, have had a large impact on mill operating variables, including quality, yield, and costs.

Pickling

During the production of hot-rolled products, exposure to cooling water and the atmosphere results in the formation of oxides on the steel surface. Further rolling of the product without removing these oxides would result in final products with poor surface quality. The oxides are removed through a process known as pickling, involving passing the hot-rolled product through a series of acid baths.

Cold (Reduction) Rolling

The term "cold rolling" refers to any process in which the product is fed into a rolling mill at ambient temperature. The name is somewhat of a misnomer, as energy generated by friction and the deformation of the material results in a temperature gain in the product. Cold rolling may be performed for a variety of reasons, including a reduction in product thickness, or imparting specific mechanical properties or a specific surface texture. Cold reduction involves a fairly large reduction in the thickness of hot rolled material; the reduction may range, for example, from 25 to 90 percent.

Annealing

The process of cold rolling steel results in changes in the steel's microstructure. These changes render the material stiffer and more brittle. In order to produce a material with more desirable working properties, the steel must be made more ductile. This is accomplished through a heat-treating process known as annealing. The annealing process involves controlled heating and cooling, relieving internal stresses in the steel imparted by the cold-rolling process and yielding a more malleable material.

Annealing can be accomplished through either a batch or continuous process. Each process has distinct advantages. Continuous annealing is accomplished in a matter of minutes, compared to up to seven days for batch annealing. Continuous annealing also offers better consistency throughout the material being processed. Batch annealing offers a greater variety in both the material to be treated and the product of the process. However, continuing modifications in steel chemistries and rolling practices have improved the abilities of continuous annealing in these areas.

Temper Rolling

Temper rolling is a process limited to sheet products. After cold-reduced sheet has been annealed, it usually is subjected to a second cold-rolling process, know as temper, or skin, rolling. In temper rolling, reductions are slight, as the primary goal of temper rolling is to fine tune the mechanical properties of the sheet.

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[12] P. Marcus, D. Barnett, and S. Iwanski, "Nucor's Revolutionary Thin-Slab/Flat-Rolling Steel Mill," June 20, 1989.

[13] "Thin strip caster rolls on at Allegheny," *Steel Times*, July 1990, p. 347.

APPENDIX G
EXCHANGE RATES

METHODOLOGY

Quarterly data on three major steel products over the 1980–89 period were analyzed to consider how U.S. import and domestic prices (adusted for general inflation in the United States), and corresponding trade and domestic shipments, were influenced by fluctuations in the real external value of the dollar (see tables G–1 through G–6). The three products, cold–rolled sheets, hot–rolled sheets, and wire–rod, account for 37 percent of U.S. net steel shipments.

The measure of currency movements used in this statistical analysis was the Federal Reserve Board's 10–country real exchange rate index. The real exchange rate was correlated with price and quantity adjustments, since changes in the nominal exchange rate which were offset by inflation differentials would leave relative competitive position in the world market unchanged.

The analysis presented here makes no attempt to isolate separate effects on supply and demand, but rather examines how exchange rates affect prices and quantities after correcting for other changes in demand and supply. The basic structure of the effects is thus that of a "reduced–form" effect of exchange rate fluctuation, which operates through changes in supply and demand for these three steel products.

Supply factors in the equations for domestic prices and quantities were measured by U.S. expenses for producing a ton of steel, deflated by general inflation in the United States this variable was omitted from the import equations. Demand factors were measured according to product use. U.S. vehicle production was used in the equations for import and domestic prices, and quantities of hot– and cold–rolled sheets; the value of new U.S. construction was used in the equations for import and domestic prices, and quantities of wire rod. Downstream demand in the export equations was approximated by real OECD gross domestic product.[1]

Ordinary least–squares regression analysis was employed (correcting for serial correlation),[2] with all variables expressed in logarithmic form, allowing resulting estimates to be interpreted as elasticities.[3] In order to consider the question of the timing of the effects of exchange rate fluctuation, lags in the effects of up to four quarters were allowed. Quarterly dummy variables were added to control for seasonal patterns of pricing and purchasing.

An important and cautionary note in interpreting these statistical results is that the exchange rate effects (or lack of effects) identified are direct effects on prices and quantities. Not considered explicitly were exchange rate effects which influence prices and quantities of domestic steel and steel imports through their effects on downstream demand or cost. The relatively small share of steel costs attributed to imported inputs suggests that these indirect cost effects are probably small. However, to the extent that automobile or construction demand is affected by exchange rate movements, steel prices and shipments would be indirectly affected by the relationship between downstream demand and exchange rate movements.

DATA DESCRIPTIONS

Descriptions of the data used as dependent variables in the regression equations and as explanatory variables follow.

Dependent Variables

Prices

Prices for U.S. domestic shipments were obtained from *Steel Strategist #17*, published by World Steel Dynamics of PaineWebber. Unit values for exports and imports were constructed from trade values and volumes compiled by the U.S. Department of Commerce. All nominal values for imports, exports, and domestic shipments were adjusted by the U.S. producer price index obtained from *International Financial Statistics*, published by the International Monetary Fund (IMF).[4]

[1] An additional binary variable, taking on the value one in years when quotas were binding or when the trigger price mechanism was in effect, and zero in other years, was included in some preliminary statistical analysis to examine whether exchange rate effects varied during periods of trade restriction. This variable seemed to have no significant impact and was not included in the results reported here.

[2] Estimates based on Aitken's generalized least squares regression method (or the "seemingly unrelated regression" technique) were not significantly different than those described below.

[3] An elasticity expresses an effect in terms of the percentage change in one variable associated with a one percent change in another variable.

[4] All values that were originally stated in nominal terms, for both dependent and explanatory variables, were adjusted by producer price indices taken from *International Financial Statistics*.

Volumes

The volumes of U.S. imports and exports, in metric tons, were obtained from statistics compiled by the U.S. Department of Commerce. The volumes of domestic shipments, also in metric tons, were obtained from *Steel Strategist #17*, published by World Steel Dynamics of Paine Webber.

Explanatory Variables

Exchange Rates

The exchange rate index which was used in the LS estimations was the multilateral trade–weighted value of the U.S. dollar published by the Board of Governors of the Federal Reserve System in the *Federal Reserve Bulletin*.

Vehicle Production

The total number of vehicles produced in the United States was obtained from *Motor Vehicle Facts and Figures*, published by the Motor Vehicle Manufacturers Association of the United States, Inc.

New Construction

The total value of new construction in the United States was obtained from statistics compiled by the U.S. Department of Commerce.

Expense Per Ton Of U.S. Steel Produced

The total expense of producing a metric ton of steel for the United States was obtained from *Steel Strategist #17*, published by World Steel Dynamics of Paine Webber.

World Gross National Product

Total gross domestic product, in real dollars, for the countries of the Organization for Economic Cooperation and Development (OECD) was used as a proxy for World Gross National Product. This value was obtained from statistics compiled by the OECD.

Table G-1
Effects of dollar appreciation and increases in downstream demand on steel import prices

	Hot rolled	*Cold rolled*	*Wire rod*
One percent appreciation:			
Contemporaneous effect (percent change)	0.08	0.24	-0.10
One quarter lagged effect (percent change)	-0.19	-0.35	0.10
Two quarter lagged effect (percent change)	-0.01	0.28	-0.51
Three quarter lagged effect (percent change)	-0.17	0.17	0.34
Four quarter lagged effect (percent change)	-0.49	-0.36	-0.09
Total effect (percent change)	-0.78	-0.36	-0.28
Signifcance	5%	1%	10%
One percent increase in downstream demand	-0.06	-0.00	-0.19
T-statistic	(0.44)	([1])	(1.47)
R^2	.43	.53	.55
Observations	32	32	32

[1] Not applicable.

Table G-2
Effects of dollar appreciation and increases in downstream demand on steel import volumes

	Hot rolled	*Cold rolled*	*Wire rod*
One percent appreciation:			
Contemporaneous effect (percent change)	-0.55	0.01	-0.39
One quarter lagged effect (percent change)	0.50	-0.24	1.46
Two quarter lagged effect (percent change)	1.83	1.77	0.62
Three quarter lagged effect (percent change)	-0.44	-0.07	-1.64
Four quarter lagged effect (percent change)	-0.67	-0.33	0.59
Total effect (percent change)	0.67	1.14	0.63
Signifcance	([1])	5%	10%
One percent increase in downstream demand	0.96	0.63	0.87
T-statistic	3.02	2.06	3.16
R^2	.51	.53	.50
Observations	34	34	34

[1] Not significant.

Table G-3
Effects of dollar appreciation, increases in steel production costs, and increases in downstream demand on steel export prices

	Hot rolled	*Cold rolled*	*Wire rod*
One percent appreciation:			
Contemporaneous effect (percent change)	1.68	0.39	-3.20
One quarter lagged effect (percent change)	-2.11	-0.09	2.20
Two quarter lagged effect (percent change)	-0.24	0.22	-0.63
Three quarter lagged effect (percent change)	0.40	-1.50	-0.99
Four quarter lagged effect (percent change)	0.48	1.50	1.62
Total effect (percent change)	0.22	0.52	-1.00
Signifcance	(1)	10%	5%
One percent increase in downstream demand	0.30	-0.10	-1.25
T-statistic	(0.34)	(0.17)	(1.09)
One percent increase in production costs	0.50	0.87	-0.05
T-statistic	(0.35)	(0.98)	(0.03)
R^2	.21	.54	.67
Observations	34	34	34

[1] Not significant.

Table G-4
Effects of dollar appreciation, increases in steel production costs, and increases in downstream demand on steel export volumes

	Hot rolled	*Cold rolled*	*Wire rod*
One percent appreciation:			
Contemporaneous effect (percent change)	-6.73	-1.07	-4.84
One quarter lagged effect (percent change)	10.91	4.33	3.52
Two quarter lagged effect (percent change)	1.01	-3.28	-2.66
Three quarter lagged effect (percent change)	-7.44	1.11	1.53
Four quarter lagged effect (percent change)	-0.36	-2.74	-4.11
Total effect (percent change)	-2.62	-1.65	-6.56
Signifcance	1%	1%	1%
One percent increase in downstream demand	-3.73	-1.98	-1.52
T-statistic	(1.27)	(1.31)	(0.38)
One percent increase in production costs	-1.46	-1.24	-8.00
T-statistic	(0.31)	(0.52)	(1.25)
R^2	.52	.56	.45
Observations	34	34	34

Table G-5
Effects of dollar appreciation, increases in steel production costs, and increases in downtown demand on domestic prices

	Hot rolled	*Cold rolled*	*Wire rod*
One percent appreciation:			
Contemporaneous effect (percent change)	-0.12	-0.03	-0.06
One quarter lagged effect (percent change)	0.10	-0.02	0.10
Two quarter lagged effect (percent change)	0.22	0.24	-0.01
Three quarter lagged effect (percent change)	-0.04	0.05	0.01
Four quarter lagged effect (percent change)	-0.09	-0.15	-0.04
Total effect (percent change)	0.07	0.09	0.00
Signifcance	(5%)	(5%)	([1])
One percent increase in downstream demand	-0.09	-0.14	0.09
T-statistic	(1.54)	(2.07)	(1.25)
One percent increase in production costs	0.05	0.06	-0.04
T-statistic	(1.68)	(1.76)	(0.90)
R^2	.69	.63	.44
Observations	34	34	34

[1] Not applicable.

Table G-6
Effects of dollar appreciation, increases in steel production costs and increases in downstream demand on domestic shipments

	Hot rolled	*Cold rolled*	*Wire rod*
One percent appreciation:			
Contemporaneous effect (percent change)	0.00	0.41	-0.03
One quarter lagged effect (percent change)	0.14	-0.21	-0.49
Two quarter lagged effect (percent change)	0.28	-0.14	-0.30
Three quarter lagged effect (percent change)	-0.29	-0.23	0.59
Four quarter lagged effect (percent change)	-0.25	0.04	-0.25
Total effect (percent change)	-0.12	-0.13	-0.48
Signifcance	([1])	([1])	([1])
One percent increase in downstream demand	-0.75	-0.33	-0.40
T-statistic	(2.15)	(1.17)	(0.90)
One percent increase in production costs	0.27	0.24	0.42
T-statistic	(1.52)	(1.66)	(1.38)
R^2	.60	.67	.71
Observations	34	34	34

[1] Not significant.

Table G–7

Annual U.S. vehicle production, annual value of new U.S. construction, U.S. prices for selected products, and U.S. domestic shipments of selected products

Year	Annual U.S. vehicle production	Value of new U.S. construction	U.S. prices: Hot-rolled sheet	U.S. prices: Cold-rolled sheet	U.S. prices: Wire rod	U.S. domestic shipments: Hot-rolled sheet	U.S. domestic shipments: Cold-rolled sheet	U.S. domestic shipments: Wire rod
		Million 1982 dollars	Dollars per metric ton			Million metric tons		
1970	8,283,949	277,618	(1)	(1)	(1)	(1)	(1)	(1)
1971	10,671,654	302,795	(1)	(1)	(1)	11.76	14.90	1.59
1972	11,310,708	323,535	(1)	(1)	(1)	14.04	16.12	1.92
1973	12,681,513	327,299	190.77	218.79	171.26	16.89	20.38	2.04
1974	10,071,042	285,186	235.61	265.18	204.96	15.77	18.27	1.86
1975	8,986,513	255,878	274.09	306.57	265.62	11.22	12.84	1.30
1976	11,497,596	277,113	293.01	330.35	293.77	15.09	18.26	1.90
1977	12,702,782	296,142	327.30	370.97	319.88	14.56	17.68	1.80
1978	12,899,202	316,200	361.95	412.12	348.00	15.42	17.82	2.55
1979	11,479,993	312,689	398.88	454.99	368.67	16.00	17.23	2.86
1980	8,009,841	281,908	420.17	480.04	406.75	12.12	13.31	2.67
1981	7,942,916	269,241	475.52	536.12	462.69	13.45	14.40	3.04
1982	6,985,595	248,004	495.88	557.98	483.60	9.05	11.13	2.41
1983	9,224,821	275,096	511.27	590.26	479.91	11.62	13.78	2.89
1984	10,924,781	309,110	538.39	627.44	492.40	13.13	13.66	3.01
1985	11,652,743	324,877	541.63	625.88	473.21	12.95	13.57	2.97
1986	11,334,775	345,869	513.61	582.84	459.65	12.17	13.25	3.46
1987	10,924,686	347,594	525.13	605.33	462.69	13.05	13.86	3.84
1988	11,211,278	352,508	551.65	637.51	497.23	12.59	13.87	4.05
1989	10,852,055	(1)	567.41	663.91	516.13	12.90	13.85	4.23

[1] Data not available.

Source: U.S. vehicle production data from Motor Vehicle Manufacturers Association of the United States, Inc., Motor Vehicle Facts and Figures, annual. New construction data compiled from official statistics of the U.S. Department of Commerce. Steel price and shipment data from PaineWebber, World Steel Dynamics, *Steel Strategist #17*, February 1991.

Table G–8
Import shares of hot–rolled sheets

(In percent)

Year	Source								
	Canada	Japan	France	Netherlands	South Korea	W. Germany	Brazil	Venezuela	Total
1970	7.17	59.67	2.45	8.86	0.28	15.82	0.30	0.00	94.54
1971	6.79	45.80	3.51	6.92	0.83	21.02	0.22	0.00	85.06
1972	8.74	47.40	2.28	9.13	3.13	18.50	0.65	0.00	89.83
1973	5.84	54.40	1.47	12.30	1.53	19.39	0.64	0.00	95.58
1974	7.13	50.81	5.35	9.53	7.21	13.18	0.00	0.00	93.21
1975	8.10	50.95	5.95	12.91	6.75	9.49	0.00	0.00	94.17
1976	9.21	51.84	14.28	9.37	6.00	3.20	0.36	0.00	94.27
1977	7.68	30.03	19.43	9.50	6.17	13.69	0.00	0.10	86.61
1978	7.39	20.16	19.29	11.26	2.18	19.63	0.26	0.13	80.31
1979	8.27	30.78	19.55	11.15	1.10	18.45	0.35	0.00	89.66
1980	9.46	35.24	19.63	11.75	1.50	13.72	0.34	0.02	91.65
1981	9.29	26.39	21.59	12.15	3.32	13.31	0.18	0.76	86.98
1982	7.52	24.94	12.21	7.91	8.22	19.67	3.31	1.03	84.81
1983	8.19	15.80	12.98	6.83	8.94	12.31	12.11	2.18	79.35
1984	14.11	15.39	10.62	5.87	7.51	10.52	7.64	4.20	75.86
1985	14.17	12.27	16.34	10.64	6.70	14.08	4.53	1.19	79.91
1986	18.04	12.65	13.94	7.88	8.82	15.60	6.57	1.14	84.64
1987	24.86	11.43	12.88	7.64	7.66	12.19	5.91	1.17	83.74
1988	20.07	14.47	10.13	9.81	8.12	11.57	5.81	0.97	80.95
1989	21.36	15.09	13.24	11.71	10.91	9.41	7.59	1.07	90.37

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table G–9
Import shares of cold–rolled sheets

(In percent)

Year	Source: Japan	W. Germany	Brazil	Canada	France	Netherlands	South Korea	United Kingdom	Italy	Spain	Argen-tina	Total
1970	36.02	24.48	0.05	6.28	4.44	10.42	0.80	9.23	0.97	0.00	1.53	94.22
1971	27.57	20.32	0.01	4.17	9.10	8.57	2.46	8.59	4.54	1.30	2.24	88.87
1972	29.13	20.92	1.65	2.04	7.60	11.36	7.89	6.21	3.89	1.02	0.54	92.25
1973	31.06	22.87	0.21	1.40	7.82	12.20	9.97	5.37	1.73	0.00	0.00	92.64
1974	33.64	21.36	0.00	1.17	8.41	11.07	11.35	2.53	1.45	0.28	0.00	91.24
1975	34.75	13.83	0.00	1.44	10.21	8.29	2.37	3.39	14.98	2.34	0.00	91.61
1976	52.20	9.07	0.34	1.49	5.08	7.40	11.64	1.52	2.32	4.16	1.02	96.24
1977	31.70	22.19	0.00	2.20	7.88	6.77	6.66	2.17	4.73	0.89	1.00	86.20
1978	28.12	20.39	0.03	3.37	8.29	7.19	11.63	0.69	6.85	2.78	2.94	92.27
1979	34.37	24.64	0.36	2.93	10.08	6.76	7.49	0.28	3.02	2.01	0.00	91.94
1980	41.62	17.30	0.34	5.06	8.38	7.96	7.02	0.06	1.14	0.56	0.00	89.45
1981	24.68	24.46	1.16	6.40	10.27	9.00	6.39	0.99	3.55	4.08	0.00	90.98
1982	18.55	24.60	2.64	3.45	9.40	9.54	4.02	1.22	2.81	3.29	6.06	85.60
1983	23.90	12.93	14.21	2.97	6.46	4.65	8.17	0.88	2.84	3.31	5.39	85.70
1984	23.97	11.30	7.34	3.56	4.27	3.70	10.99	0.67	2.36	6.42	4.25	78.83
1985	23.44	13.65	4.50	4.59	6.47	5.70	10.09	1.16	3.67	2.24	3.74	79.24
1986	21.29	16.07	5.50	5.32	5.94	6.19	11.19	0.99	3.69	2.98	2.67	81.83
1987	23.35	14.79	7.74	7.93	6.24	5.28	11.16	0.78	2.41	2.28	3.71	85.68
1988	25.15	15.33	5.61	5.57	6.69	6.52	8.52	1.16	2.69	2.15	4.27	83.65
1989	28.73	12.17	10.93	7.48	7.30	6.24	4.72	1.38	2.17	3.79	0.37	85.28

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table G–10
Import shares of wire rod

(In percent)

Year	Source: Canada	Japan	France	Turkey	Brazil	W. Germany	United Kingdom	Mexico	Spain	Argentina	Venezuela	Sweden	Belgium-Luxemburg	Taiwan	Total
1970	5.31	37.67	21.85	0.00	0.00	16.12	7.01	0.00	0.00	0.85	0.00	2.91	2.85	0.00	94.55
1971	5.78	27.45	25.98	0.00	0.89	15.85	11.14	0.01	1.99	0.00	0.00	2.12	4.88	0.00	96.09
1972	4.38	27.47	26.26	0.00	1.97	15.57	11.63	1.20	0.00	0.39	0.00	2.72	4.21	0.00	95.82
1973	5.59	28.02	23.75	0.00	0.02	17.59	12.39	0.11	0.19	0.98	0.00	3.58	2.84	0.00	95.07
1974	4.41	22.61	21.29	0.00	0.43	24.91	5.45	0.00	0.01	0.74	0.00	1.70	5.93	0.00	87.48
1975	4.27	46.61	14.98	0.00	1.86	18.88	3.73	0.00	0.01	0.00	0.00	1.71	4.06	0.00	96.11
1976	9.61	41.38	17.04	0.00	1.85	15.15	3.07	1.43	0.01	0.82	0.00	1.82	4.02	0.03	96.23
1977	12.71	37.04	21.20	0.00	2.28	8.67	5.87	1.64	0.26	0.67	0.00	1.26	3.35	0.00	94.94
1978	21.75	30.55	14.85	0.00	3.91	5.18	6.17	0.16	1.02	0.65	0.00	1.26	2.82	1.68	90.00
1979	33.86	36.29	11.35	0.00	0.00	6.01	1.35	0.05	0.07	0.00	0.00	1.82	3.25	1.18	95.23
1980	44.68	29.62	12.66	0.00	0.00	1.97	0.12	0.00	0.66	0.00	0.54	1.34	2.53	0.09	94.20
1981	37.16	24.77	13.06	0.00	3.85	2.53	3.32	0.00	0.50	2.38	2.86	2.21	2.70	0.00	95.35
1982	31.36	19.85	12.81	0.00	11.92	1.67	1.53	3.24	0.98	1.71	0.00	1.47	3.03	0.00	89.56
1983	24.50	19.22	6.81	0.00	6.59	1.73	1.92	9.02	7.24	5.77	0.00	2.48	0.82	0.05	86.15
1984	23.17	21.22	7.53	0.21	2.22	1.42	2.63	7.89	8.40	3.90	1.36	2.04	1.12	0.18	83.29
1985	23.91	19.76	10.12	0.00	3.13	3.02	3.03	2.55	2.31	0.00	3.81	3.59	1.33	0.65	77.21
1986	25.55	19.75	8.88	1.73	3.79	1.79	3.78	4.46	3.92	0.08	0.17	3.35	2.00	2.98	82.23
1987	26.59	17.12	6.77	4.16	3.48	2.65	3.51	4.28	2.85	0.00	0.30	0.96	1.40	1.08	75.17
1988	24.11	18.84	9.34	8.49	3.97	2.29	3.76	3.91	2.63	0.00	0.60	1.45	0.46	1.14	80.97
1989	36.20	17.46	10.65	6.83	5.25	0.80	1.36	2.92	4.28	0.00	0.19	0.50	1.49	0.91	88.84

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table G-11
Total cost per ton of steel produced and U.S. imports of selected steel products

Year	Total cost per ton of steel produced					U.S. imports					
	U.S.A.	Japan	F.R.G.	U.K.	France	Hot-rolled sheet	Cold-rolled sheet	Wire rod	Hot-rolled sheet	Cold-rolled sheet	Wire rod
	Dollars					1,000 dollars			Million metric tons		
1970	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	2.00	2.29	1.06
1971	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	2.66	3.69	1.54
1972	(1)	(1)	(1)	(1)	(1)	272,508	517,016	188,789	2.23	3.34	1.40
1973	209.9	186.2	210.9	187.4	235.1	246,877	483,995	229,258	1.79	2.77	1.42
1974	258.2	232.2	258.7	271.1	299.4	412,724	790,404	581,611	1.65	2.64	1.95
1975	327.9	271.6	321.2	351.8	396.8	325,194	573,921	349,576	1.51	2.16	1.11
1976	354.8	284.8	330.7	322.9	381.3	322,567	643,049	289,400	1.64	2.45	1.12
1977	388.1	326.4	362.5	366.9	424.1	551,301	968,419	345,039	2.67	3.45	1.34
1978	403.1	390.1	402.5	432.6	439.7	612,924	1,022,262	389,177	2.62	3.23	1.33
1979	445.1	389.3	428.4	508.4	509.7	608,111	894,821	379,156	2.16	2.41	0.99
1980	522.3	435.2	481.7	590.1	564.1	441,740	589,037	347,210	1.49	1.48	0.83
1981	553.4	483.1	422.8	536.8	540.6	526,902	720,356	388,315	1.63	1.63	0.89
1982	683.6	448.4	436.4	463.2	549.3	421,498	747,464	366,222	1.35	1.71	0.94
1983	593.6	452.8	415.9	403.9	466.3	868,611	1,429,823	381,888	2.32	2.42	1.19
1984	555.8	403.6	373.0	371.0	418.0	607,907	879,642	522,496	3.03	3.59	1.59
1985	523.2	395.9	357.7	360.7	407.7	794,660	1,158,673	486,209	2.79	2.70	1.46
1986	509.2	504.6	429.2	378.9	475.0	662,932	1,104,140	455,855	2.40	2.69	1.36
1987	477.9	510.1	472.6	379.4	489.2	767,023	1,031,254	485,314	2.52	2.24	1.47
1988	478.2	528.7	477.0	410.6	450.8	810,865	1,109,791	557,092	2.21	2.11	1.49
1989	491.7	505.6	463.7	407.1	448.3	729,420	1,060,507	445,306	1.90	1.88	1.11

[1] Data not available.

Source: Expense per ton data compiled from PaineWebber, World Steel Dynamics, *Steel Strategist #17*, February 1991; import data compiled from official statistics of U.S. Department of Commerce.

APPENDIX H
ESTIMATED COSTS

Table H-1
Cold-rolled sheet: Estimated costs, at actual operating rates, as of first-quarter 1991, by selected country

Item	*United States*	*Japan*	*Germany*	*United Kingdom*	*Canada*	*Korea*	*Brazil*	*Taiwan*
Assumptions:								
Exchange rate (local currency/ U.S. dollar)	US$1.00	¥134	DM1.56	£0.53	C$1.15	Won722	Cr227.7	NT$27.2
Operating rate[1] (percent)	80.2	92.7	84.1	79.9	71.4	94.3	82.4	88.3
Yield ratio (percent)	84.7	88.9	86.7	85.4	82.9	83.6	78.3	82.1
	U.S. dollars per metric ton shipped							
Energy and materials cost	344	348	353	352	340	349	322	348
Labor cost:								
Employment cost/hour	27.2	26.9	27.0	20.9	25.6	8.9	4.5	8.7
Manhours/ton	5.9	6.2	6.2	6.1	6.3	7.7	9.0	7.9
Total labor cost	160	167	167	127	161	69	41	69
Other, including sales, general, and administrative	29	36	28	25	35	24	32	31
Total operating cost	533	551	548	504	536	441	395	448
Financial expense	32	79	20	12	42	104	147	94
Pretax cost	565	630	568	516	578	545	542	542
Ranking (low cost is 1)	5	8	6	1	7	4	2	3

[1] Operating rate is the percent of a plant's effective capacity that is being utilized.

Source: The WEFA Group, *U.S. & World Executive Steel Report*, June 1, 1991.

Table H-2
Cold-rolled coil: Estimated costs at actual operating rates as of second quarter, 1991

Item	*United States*	*Japan*	*Germany*	*United Kingdom*	*France*	*Korea*	*Taiwan*	*Brazil*
Assumptions:								
Exchange rate (local currency/ U.S. dollar)	US$1.00	¥126	DM1.5	£1.9	FFr5.25	Won752	NT$25	([1])
Operating rate[2] (percent)	85	85	80	85	80	100	95	80
	U.S. dollars per metric ton shipped							
Raw materials:								
Iron Ore	58	41	40	31	38	37	35	30
Scrap	9	1	7	12	9	2	7	-1
Coal	44	57	53	42	49	54	55	82
Total raw materials	111	99	99	85	96	93	97	111
Other materials	120	136	161	146	136	130	128	129
Energy:								
Electricity	19	35	24	22	21	26	24	17
Other energy	3	3	0	4	1	8	8	11
Total energy costs	23	37	24	26	22	33	32	28
Labor	145	144	172	134	141	48	78	36
Maintenance	32	39	34	36	33	36	33	36
Operating cost	430	454	489	427	427	339	366	339
Financial costs:								
Depreciation	26	71	45	25	50	110	65	80
Interest	18	14	12	2	20	55	10	50
Taxes	8	11	9	8	9	2	2	4
Total financial costs	52	96	66	35	79	167	77	134
Total cost	482	550	555	462	506	506	443	473
Ranking (low cost is 1)	4	7	8	2	5	5	1	3

[1] Not provided.
[2] Operating rate is the percent of a plant's effective capacity that is being utilized.

Source: Donald F. Barnett, Economic Associates, Inc.

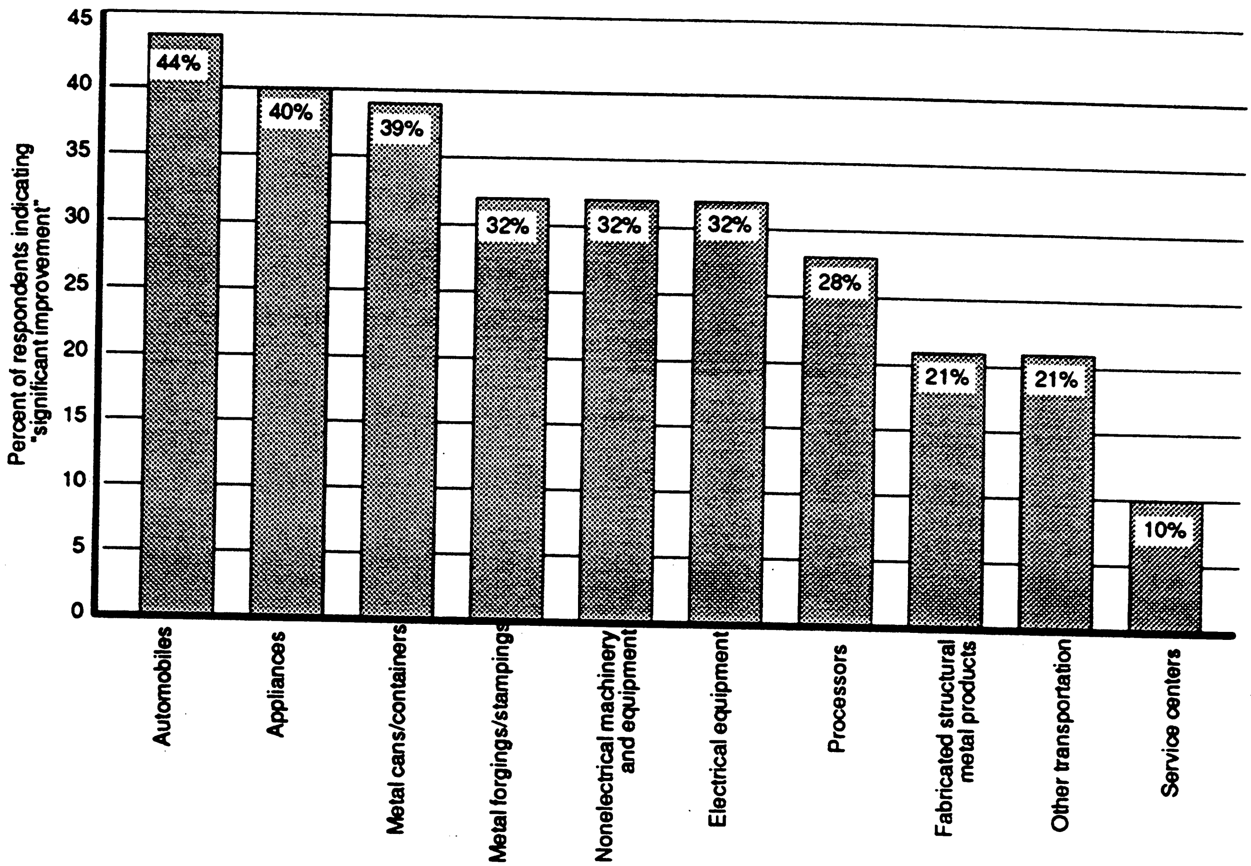
Table H-3
Cold-rolled sheet: Estimated cost, at standard operating rates, as of March 1991

Item	*United States*	*Japan*	*Germany*	*United Kingdom*	*France*	*Canada*	*Australia*	*Korea*	*Taiwan*	*Brazil*
Assumptions:										
Exchange rate (local currency/ U.S. dollar)	US$1.00	¥137	DM1.60	£0.56	FFr5.60	C$1.16	A$1.30	Won725	NT$26.8	(1)
Operating rate[2] (percent)	80	90	90	90	90	90	90	90	90	90
	U.S. dollars per metric ton shipped									
Energy and materials cost ...	317	321	320	315	308	310	315	335	340	365
Labor cost:										
Employment cost/hour	28	24	30	22	24	25	20	8	11	4
Manhours per ton	5.4	5.5	5.7	5.7	5.6	5.7	6.6	7.2	7.0	11.0
Total labor cost ...	151	132	171	125	134	143	132	57	77	44
Total operating cost	468	454	491	440	442	453	447	392	417	409
Financial cost	39	83	49	22	38	30	33	129	79	130
Pretax cost	507	537	540	462	480	483	480	521	496	539
Ranking (low cost is 1)	6	8	10	1	2	4	2	7	5	9

[1] Not provided.
[2] Operating rate is the percent of a plant's effective capacity that is being utilized.
Source: PaineWebber, *Steel Price Track #34,* April 5, 1991, p. 30.

APPENDIX I
QUALITY AND SERVICE RANKING FOR THE U.S. AND JAPANESE STEEL INDUSTRIES

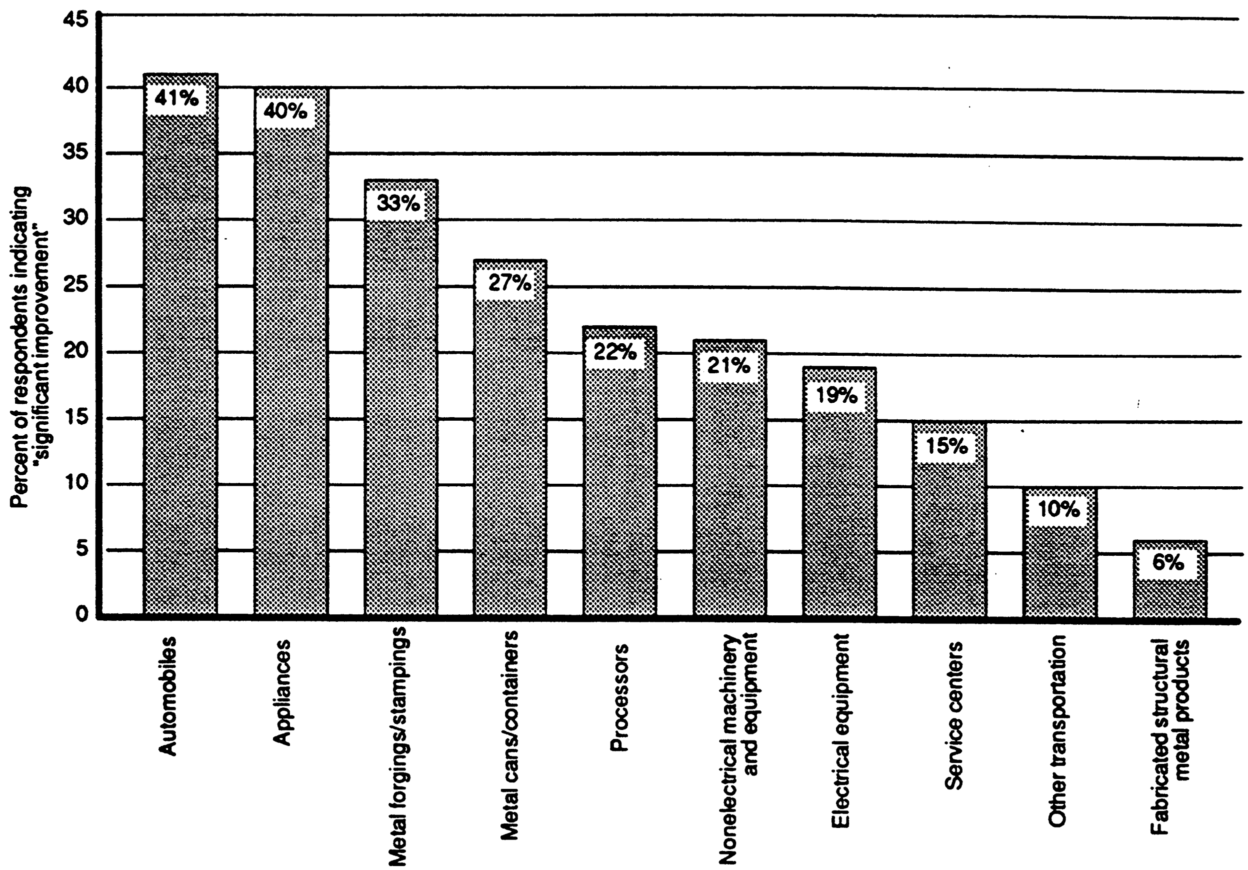
Figure I-1
Purchasers' assessments[1] of improvement in U.S. product quality from 1985 to 1990, by consuming group



[1] U.S. steel purchasers were asked to provide an assessment of the change in the performance of the U.S. steel producers with whom they conduct business. Possible assessments were "significant improvement", "moderate improvement", or "little or no improvement."

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Figure I-2
Purchasers' assessments[1] of improvement in U.S. customer service from 1985 to 1990, by consuming group



[1] U.S. steel purchasers were asked to provide an assessment of the change in the performance of the U.S. steel producers with whom they conduct business. Possible assessments were "significant improvement", "moderate improvement", or "little or no improvement."

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-1
Purchasers' assessments[1] of the extent to which U.S. steel producers have improved their overall product quality and service from 1985 to 1990, by size of purchaser

Element/ purchaser size	Degree of improvement				
	Little or none	Limited	Significant	No. of responses	No. of respondents
	Percent				
Quality[2]:					
Small purchasers[3]	33	48	19	153	62
Medium purchasers[4]	11	55	34	195	100
Large purchasers[5]	10	58	32	103	44
Service[6]:					
Small purchasers[3]	17	60	23	149	59
Medium purchasers[4]	22	54	25	199	100
Large purchasers[5]	22	62	16	111	45

[1] U.S. steel purchasers were asked to provide an assessment of the performance of the U.S. steel producers with whom they conduct business.

[2] Reflects an overall assessment of quality on the basis of the relative importance of each of the following elements: internal quality; dimensional quality; surface quality; properties; and presentation.

[3] Purchase less than 10,000 tons-per-year.

[4] Purchase between 10,000 and 100,000 tons-per-year.

[5] Purchase more than 100,000 tons-per-year.

[6] Reflects an overall assessment of service on the basis of the relative importance of each of the following elements: delivery reliability; technical assistance; responsiveness to complaints; and financial terms.

Note.—The number of responses exceeds the number of respondents as respondents were asked to provide evaluations on up to six product groups.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-2
Metal cans and shipping containers: Assessment[1] of U.S. steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall[4]	22	56	22	0	9	8
Internal quality[5]	11	44	44	0	9	8
Dimensional quality[6]	22	44	33	0	9	8
Surface quality[7]	22	44	22	11	9	8
Properties[8]	22	44	22	11	9	8
Presentation[9]	11	56	22	11	9	8
Service:						
Overall[4]	11	67	22	0	9	8
Delivery reliability	22	56	22	0	9	8
Pre- and post-sale technical assistance	11	56	22	11	9	8
Responsiveness to complaints	11	56	22	11	9	8
Financial terms[10]	33	22	22	22	9	8

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.
[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.
[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).
[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.
[5] Includes chemistry, microstructure, grain size, and inclusions.
[6] Includes shape, size, length, straightness, and flatness.
[7] Includes seams, smoothness, and shearing.
[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.
[9] Includes packaging and marking.
[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-3
Fabricated structural metal products: Assessment[1] of U.S. steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall[4]	0	44	42	14	64	19
Internal quality[5]	0	39	44	17	64	19
Dimensional quality[6]	0	44	39	17	64	19
Surface quality[7]	2	41	42	16	64	19
Properties[8]	0	33	38	30	64	19
Presentation[9]	3	38	46	13	63	19
Service:						
Overall[4]	8	47	42	3	64	19
Delivery reliability	16	58	23	3	64	19
Pre- and post-sale technical assistance	7	48	32	13	62	19
Responsiveness to complaints	8	47	41	5	64	19
Financial terms[10]	7	60	24	9	58	17

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-4
Metal forgings and stampings: Assessment[1] of U.S. steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall[4]	4	29	67	0	24	11
Internal quality[5]	0	23	77	0	22	10
Dimensional quality[6]	4	25	67	4	24	11
Surface quality[7]	4	42	50	4	24	11
Properties[8]	4	39	57	0	23	11
Presentation[9]	10	29	57	5	21	10
Service:						
Overall[4]	8	50	38	4	24	11
Delivery reliability	13	33	50	4	24	11
Pre- and post-sale technical assistance	18	41	36	5	22	11
Responsiveness to complaints	4	57	35	4	23	11
Financial terms[10]	22	61	17	0	23	11

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.
[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.
[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).
[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.
[5] Includes chemistry, microstructure, grain size, and inclusions.
[6] Includes shape, size, length, straightness, and flatness.
[7] Includes seams, smoothness, and shearing.
[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.
[9] Includes packaging and marking.
[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-5
Nonelectrical machinery and equipment: Assessment[1] of U.S. steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall[4]	2	33	58	8	64	23
Internal quality[5]	2	32	55	12	60	22
Dimensional quality[6]	5	28	58	9	64	23
Surface quality[7]	2	37	48	13	60	23
Properties[8]	2	32	46	20	56	21
Presentation[9]	5	30	47	18	57	21
Service:						
Overall[4]	2	36	50	13	64	23
Delivery reliability	5	44	34	17	64	23
Pre- and post-sale technical assistance	2	41	42	16	64	23
Responsiveness to complaints	5	37	42	16	62	23
Financial terms[10]	2	45	36	17	58	22

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-6
Appliances: Assessment[1] of U.S. steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall[4]	0	64	27	9	11	5
Internal quality[5]	0	50	38	13	8	3
Dimensional quality[6]	0	64	27	9	11	5
Surface quality[7]	0	64	27	9	11	5
Properties[8]	0	50	13	38	8	3
Presentation[9]	0	64	18	18	11	5
Service:						
Overall[4]	0	64	18	18	11	5
Delivery reliability	9	36	18	36	11	5
Pre- and post-sale technical assistance	0	36	36	27	11	5
Responsiveness to complaints	0	36	9	55	11	5
Financial terms[10]	0	13	25	63	8	3

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-7
Electrical equipment: Assessment[1] of U.S. steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall[4]	3	39	58	0	31	11
Internal quality[5]	0	39	61	0	31	11
Dimensional quality[6]	0	48	52	0	31	11
Surface quality[7]	3	39	58	0	31	11
Properties[8]	7	36	58	0	31	11
Presentation[9]	7	32	61	0	31	11
Service:						
Overall[4]	23	26	52	0	31	11
Delivery reliability	23	32	45	0	31	11
Pre- and post-sale technical assistance	0	45	52	3	31	11
Responsiveness to complaints	7	36	52	7	31	11
Financial terms[10]	14	45	41	0	29	11

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-8
Automobiles: Assessment[1] of U.S. steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall[4]	1	33	60	7	77	25
Internal quality[5]	0	37	56	7	75	25
Dimensional quality[6]	1	39	56	4	77	25
Surface quality[7]	3	38	52	8	77	25
Properties[8]	1	28	62	9	76	24
Presentation[9]	1	37	42	20	76	25
Service:						
Overall[4]	4	25	65	7	77	25
Delivery reliability	7	41	42	11	76	25
Pre- and post-sale technical assistance	4	28	51	16	74	24
Responsiveness to complaints	7	29	51	13	75	25
Financial terms[10]	8	26	55	11	76	24

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.
[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.
[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).
[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.
[5] Includes chemistry, microstructure, grain size, and inclusions.
[6] Includes shape, size, length, straightness, and flatness.
[7] Includes seams, smoothness, and shearing.
[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.
[9] Includes packaging and marking.
[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-9
Other transportation: Assessment[1] of U.S. steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall[4]	0	69	23	8	13	3
Internal quality[5]	8	62	23	8	13	3
Dimensional quality[6]	0	77	15	8	13	3
Surface quality[7]	0	69	23	8	13	3
Properties[8]	0	62	31	8	13	3
Presentation[9]	0	54	39	8	13	3
Service:						
Overall[4]	8	69	15	8	13	3
Delivery reliability	8	77	8	8	13	3
Pre- and post-sale technical assistance	15	69	15	0	13	3
Responsiveness to complaints	0	92	8	0	13	3
Financial terms[10]	0	85	15	0	13	3

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-10
Service centers: Assessment[1] of U.S. steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall[4]	0	44	33	22	18	4
Internal quality[5]	0	38	17	46	24	6
Dimensional quality[6]	0	38	21	42	24	6
Surface quality[7]	0	33	29	38	24	6
Properties[8]	0	38	21	42	24	6
Presentation[9]	8	25	46	21	24	6
Service:						
Overall[4]	2	21	51	26	43	9
Delivery reliability	7	34	50	9	44	9
Pre- and post-sale technical assistance	0	36	43	21	44	9
Responsiveness to complaints	2	27	46	25	44	9
Financial terms[10]	0	28	38	34	32	7

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-11
Processors: Assessment[1] of U.S. steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents*[3]
	Percent					
Quality:						
Overall[4]	1	40	54	6	86	65
Internal quality[5]	2	38	51	9	85	65
Dimensional quality[6]	0	43	44	14	87	66
Surface quality[7]	4	45	42	9	86	65
Properties[8]	1	30	46	23	84	64
Presentation[9]	2	33	47	18	85	64
Service:						
Overall[4]	5	43	41	11	83	63
Delivery reliability	16	41	36	8	84	64
Pre- and post-sale technical assistance	7	31	45	17	82	63
Responsiveness to complaints	8	32	42	18	84	64
Financial terms[10]	9	43	32	17	82	62

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.
[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.
[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).
[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.
[5] Includes chemistry, microstructure, grain size, and inclusions.
[6] Includes shape, size, length, straightness, and flatness.
[7] Includes seams, smoothness, and shearing.
[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.
[9] Includes packaging and marking.
[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-12
Purchasers' assessments[1] of overall U.S. steel product quality[2] and customer service[3], by size of purchaser, 1990

Factor/ purchaser size	*Less than satis-factory*	*Satis-factory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents*
	Percent					
Quality:						
Small[4]	2	56	34	8	167	60
Medium[5]	2	37	58	4	208	105
Large[6]	1	41	47	11	116	45
Customer service:						
Small[4]	9	42	42	8	163	58
Medium[5]	4	38	50	8	208	103
Large[6]	4	38	47	11	141	49

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business. The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[2] Reflects an overall assessment of quality on the basis of the relative importance of each of the following elements: internal quality; dimensional quality; surface quality; properties; and presentation.

[3] Reflects an overall assessment of service on the basis of the relative importance of each of the following elements: delivery reliability; technical assistance; responsiveness to complaints; and financial terms.

[4] Purchase less than 10,000 tons-per-year.

[5] Purchase between 10,000 and 100,000 tons-per-year.

[6] Purchase more than 100,000 tons-per-year.

Note.—The number of responses exceeds the number of respondents as respondents were asked to provide evaluations on up to six product groups.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-13
Purchasers' assessments[1] of overall Japanese steel product quality,[2] by consuming group, 1990

Consuming group	Less than satisfactory	Satis-factory	Good	Excellent	No. of responses
	Percent				
Metal cans/containers ...	0	17	50	33	6
Fabricated structural metal products	0	0	33	67	15
Metal forgings/stampings .	0	0	100	0	4
Nonelectrical machinery and equipment	0	30	10	60	10
Appliances	(3)	(3)	(3)	(3)	(3)
Electrical equipment	17	50	17	17	6
Automobiles	0	11	63	26	19
Other transportation	(3)	(3)	(3)	(3)	(3)
Service centers	0	15	39	46	13
Processors	0	7	35	59	29

[1] Assessments of Japanese performance were made by purchasers for companies with whom they conducted business.

[2] The term "satisfactory" was defined in questionnaires as follows: periodic problems encountered, but problems are effectively resolved. "Good" was defined as "occasional minor problems." "Excellent" was defined as "virtually no problems encountered."

[3] Insufficient response (less than 4) provided.

Note.—Totals may not add to 100 percent because of rounding.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-14
Purchasers' assessments[1] of overall Japanese customer service,[2] by consuming group, April 1990

Consuming group	*Less than satisfactory*	*Satis-factory*	*Good*	*Excellent*	*No. of responses*
	Percent				
Metal cans/containers	17	50	17	17	6
Fabricated structural metal products	0	27	33	40	15
Metal forgings/stampings	0	25	75	0	4
Nonelectrical machinery and equipment	0	40	30	30	10
Appliances	(3)	(3)	(3)	(3)	(3)
Electrical equipment	50	17	17	17	6
Automobiles	5	21	53	21	19
Other transportation	(3)	(3)	(3)	(3)	(3)
Service centers	0	56	26	19	27
Processors	4	31	58	8	26

[1] Assessments of Japanese performance were made by purchasers for companies with whom they conducted business.

[2] The term "satisfactory" was defined in questionnaires as follows: periodic problems encountered, but problems are effectively resolved. "Good" was defined as "occasional minor problems." "Excellent" was defined as "virtually no problems encountered."

[3] Insufficient response (less than 4) provided.

Note.—Totals may not add to 100 percent because of rounding.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-15
Metal cans and shipping containers: Assessment[1] of Japanese steel product quality and customer service,[2] April 1990

Element	Satisfactory	Less than satisfactory	Good	Excellent	No. of responses	No. of respondents[3]
	Percent					
Quality:						
Overall[4]	0	17	50	33	6	5
Internal quality[5]	17	0	50	33	6	5
Dimensional quality[6]	17	0	50	33	6	5
Surface quality[7]	17	17	17	50	6	5
Properties[8]	33	0	33	33	6	5
Presentation[9]	0	0	50	50	6	5
Service:						
Overall[4]	17	50	17	17	6	5
Delivery reliability	17	33	50	0	6	5
Pre- and post-sale technical assistance	17	50	17	17	6	5
Responsiveness to complaints	17	0	67	17	6	5
Financial terms[10]	17	17	50	17	6	5

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-16
Fabricated structural metal products: Assessment[1] of Japanese steel product quality and customer service,[2] April 1990

Element	Satisfactory	Less than satisfactory	Good	Excellent	No. of responses	No. of respondents[3]
	Percent					
Quality:						
Overall[4]	0	0	33	67	15	6
Internal quality[5]	0	0	27	73	15	6
Dimensional quality[6]	0	7	20	73	15	6
Surface quality[7]	0	0	27	73	15	6
Properties[8]	0	7	13	80	15	6
Presentation[9]	0	14	36	50	14	6
Service:						
Overall[4]	0	27	33	40	15	6
Delivery reliability	7	7	53	33	15	6
Pre- and post-sale technical assistance	8	31	15	46	13	6
Responsiveness to complaints	0	40	13	47	15	6
Financial terms[10]	10	50	10	30	10	4

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.
[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.
[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).
[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.
[5] Includes chemistry, microstructure, grain size, and inclusions.
[6] Includes shape, size, length, straightness, and flatness.
[7] Includes seams, smoothness, and shearing.
[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.
[9] Includes packaging and marking.
[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-17
Metal forgings and stampings: Assessment[1] of Japanese steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents*[3]
	Percent					
Quality:						
Overall [4]	0	0	100	0	4	3
Internal quality [5]	0	0	100	0	4	3
Dimensional quality [6]	0	25	25	50	4	3
Surface quality [7]	0	25	50	25	4	3
Properties [8]	0	50	0	50	4	3
Presentation [9]	0	25	0	75	4	3
Service:						
Overall [4]	0	25	75	0	4	3
Delivery reliability	0	50	25	25	4	3
Pre- and post-sale technical assistance	25	0	50	25	4	3
Responsiveness to complaints	25	25	0	50	4	3
Financial terms [10]	25	25	50	0	4	3

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-18
Nonelectrical machinery and equipment: Assessment[1] of Japanese steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall [4]	0	30	10	60	10	6
Internal quality [5]	0	0	29	71	7	5
Dimensional quality [6]	0	20	30	50	10	6
Surface quality [7]	0	22	44	33	9	5
Properties [8]	0	13	50	38	8	4
Presentation [9]	13	0	25	63	8	4
Service:						
Overall [4]	0	40	30	30	10	6
Delivery reliability	10	40	50	0	10	6
Pre- and post-sale technical assistance	0	40	50	10	10	6
Responsiveness to complaints	0	40	40	20	10	6
Financial terms [10]	0	44	33	22	9	5

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-19
Electrical equipment: Assessment[1] of Japanese steel product quality and customer service, April 1990

Element	Satisfactory	Less than satisfactory	Good	Excellent	No. of responses	No. of respondents[3]
	Percent					
Quality:						
Overall[4]	17	50	17	17	6	4
Internal quality[5]	0	50	33	17	6	4
Dimensional quality[6]	17	33	33	17	6	4
Surface quality[7]	0	50	33	17	6	4
Properties[8]	0	50	33	17	6	4
Presentation[9]	0	50	17	33	6	4
Service:						
Overall[4]	50	17	17	17	6	4
Delivery reliability	50	0	33	17	6	4
Pre- and post- sale technical assistance	17	33	33	17	6	4
Responsiveness to complaints	33	33	17	17	6	4
Financial terms[10]	40	0	40	20	5	4

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-20
Automobiles: Assessment[1] of Japanese steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents[3]*
	Percent					
Quality:						
Overall [4]	0	11	63	26	19	13
Internal quality [5]	6	0	50	44	18	13
Dimensional quality [6]	0	5	47	47	19	13
Surface quality [7]	0	5	26	68	19	13
Properties [8]	0	11	32	58	19	13
Presentation [9]	0	16	58	26	19	13
Service:						
Overall [4]	5	21	53	21	19	13
Delivery reliability	11	26	47	16	19	13
Pre- and post-sale technical assistance	24	6	41	29	17	12
Responsiveness to complaints	17	11	50	22	18	13
Financial terms [10]	6	41	35	18	17	12

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-21
Service centers: Assessment[1] of Japanese steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents*[3]
	Percent					
Quality:						
Overall[4]	0	15	39	46	13	4
Internal quality[5]	0	21	36	43	14	4
Dimensional quality[6]	0	14	21	64	14	4
Surface quality[7]	0	14	21	64	14	4
Properties[8]	0	21	21	57	14	4
Presentation[9]	0	29	29	43	14	4
Service:						
Overall[4]	0	56	26	19	27	8
Delivery reliability	0	64	18	18	28	8
Pre- and post-sale technical assistance	7	57	18	18	28	8
Responsiveness to complaints	11	43	29	18	28	8
Financial terms[10]	5	32	32	32	19	5

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table I-22
Processors: Assessment[1] of Japanese steel product quality and customer service,[2] April 1990

Element	*Satisfactory*	*Less than satisfactory*	*Good*	*Excellent*	*No. of responses*	*No. of respondents*[3]
	Percent					
Quality:						
Overall [4]	0	7	35	59	29	23
Internal quality [5]	0	7	28	66	29	23
Dimensional quality [6]	0	10	31	59	29	23
Surface quality [7]	0	7	36	57	28	22
Properties [8]	0	7	32	61	28	22
Presentation [9]	0	7	36	57	28	22
Service:						
Overall [4]	4	31	58	8	26	20
Delivery reliability	4	39	39	19	26	20
Pre- and post-sale technical assistance	8	35	46	12	26	20
Responsiveness to complaints	4	39	42	15	26	20
Financial terms [10]	4	31	54	12	26	20

[1] Assessments of country's performance were made by purchasers for companies with whom they conducted business.

[2] The term satisfactory was further defined in questionnaires as follows: periodic problems encountered but problems are effectively resolved. Good was further defined as occasional minor problems. Excellent was defined as virtually no problems encountered.

[3] Respondents were requested to provide evaluations on up to six product groups; the request to provide multiple responses explains why the number of responses exceeds the number of respondents. See the 1990 report for further details on the product groups (USITC publication 2316, September 1990).

[4] Reflects an overall assessment of quality/customer service on the basis of the relative importance of each of the listed elements.

[5] Includes chemistry, microstructure, grain size, and inclusions.

[6] Includes shape, size, length, straightness, and flatness.

[7] Includes seams, smoothness, and shearing.

[8] Includes tensile strength, ductility, hardness, wear and corrosion resistance, and weldability.

[9] Includes packaging and marking.

[10] Includes credit terms, credit availability, and relative interest rates.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

APPENDIX J
U.S. INDUSTRY CONDITIONS

Table J-1
Steel: Producers' purchases and shipments of mill products, by quantity and value, 1990.

Product *Value*	*Purchases*		*Shipments*		
	Domestic	*Other*[1]	*Net*[2]	*Total*	*Value*
	1,000 short tons				(1,000 dollars)
Carbon and certain alloy steel:[3]					
Ingots, blooms, billets, slabs and sheet bars	1,450	2,213	(147)	3,516	1,123,081
Sheets and strip	4,212	1,286	40,806	46,304	22,449,853
Plate	75	109	6,479	6,662	3,068,360
Bars	1,549	805	10,546	12,900	5,395,186
Structural shapes and units	4	(5)	5,887	5,891	2,176,170
Rails and related railway products[4]	151	185	278	614	324,608
Wire rod	1,354	231	2,569	4,154	1,400,745
Wire and wire products	8	34	2,428	2,470	1,701,623
Pipe and tube	174	56	5,910	6,140	4,357,456
Subtotal, carbon and certain alloy[5]	8,977	4,919	74,756	88,652	41,997,082
Stainless and alloy tool steel:					
Ingots, blooms, billets, slabs, and sheet bars	98	13	55	166	253,791
Sheet and strip	151	10	876	1,036	2,216,242
Plate	2	0	194	195	534,212
Bars and shapes	(6)	2	224	226	801,127
Wire rod	401	14	79	494	338,153
Wire	(6)	(6)	65	65	161,183
Pipes and tubes	0	1	17	18	108,539
Subtotal, stainless and alloy tool steel[5]	652	39	1,508	2,200	4,413,247
Grand total[5]	9,629	4,958	76,265	90,852	46,410,329

[1] Includes purchases from unknown sources, which accounted for 1,062,350 tons, and imports.
[2] Total shipments less purchases.
[3] Certain alloy refers to alloy steel other than stainless or tool steel.
[4] Includes rails purchased for rerolling into other shapes.
[5] Totals may not add due to rounding.
[6] Less than 1,000.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-2
Certain steel products: Annual steel purchases by consuming industries, by product and grade of steel, 1990

Product	Purchases	
	Quantity	*Value*
	Tons	*1,000 dollars*
Carbon and certain alloy steel:		
Semifinished	387,505	195,175
Sheets and strip	18,120,689	10,335,145
Plate	1,663,948	893,736
Bars and light shapes	2,512,804	1,358,881
Structurals	734,020	305,965
Rails and railway products	463,781	247,721
Wire rod	98,924	61,946
Wire and wire products	104,202	95,640
Pipe and tube	762,462	680,372
Total	24,848,336	14,174,580
Stainless and alloy tool steel:		
Semifinished	1,090	15,806
Sheet and strip	325,748	707,444
Plate	56,935	161,416
Bars and shapes	53,416	214,679
Wire rod	679	8,368
Wire and wire products	15,632	26,392
Pipe and tube	393,524	420,459
Total	847,023	1,554,565
All grades of steel:		
Total	25,695,359	15,729,145

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-3
Steel: U.S. producers' reported capacity and production, 1990, and capacity utilization, 1990 and January-March, 1991.

Item	*Capacity*	*Production*	*Capacity utilization*	
			1990	*Jan-Mar. 1991*
	1,000 tons		*Percent*	
Certain carbon and alloy steel:				
Cokemaking	26,309	22,617	86	76
Ironmaking	70,803	53,825	76	65
Steelmaking				
Basic oxygen process	66,998	57,843	86	74
Electric furnace	42,608	34,596	81	66
Other	***	***	44	28
Products:				
Sheets and strip				
Hot-rolled	68,582	52,457	76	61
Cold-rolled	38,037	27,720	73	57
Galvanized	12,701	10,747	85	63
Other coated	6,590	5,589	85	78
Plates	7,844	5,109	65	42
Bars and light structurals				
Hot-finished	19,429	15,457	80	70
Cold-finished	2,433	1,473	61	64
Medium and heavy structurals[1]	6,845	4,511	66	49
Pipes and tubes				
Seamless pipes	2,527	1,695	67	75
Welded pipes	7,402	4,063	55	42
Other pipe and tube	592	455	77	48
Rails and rail products	***	***	51	62
Wire rods	6,111	5,022	82	94
Wire	3,341	2,587	77	76
Wire products	2,174	1,880	86	59
Stainless and alloy tool steel:				
Electric furnace	2,483	1,944	78	86
Products:				
Sheets and strip				
Hot-rolled	977	756	77	79
Cold-rolled	924	700	76	69
Plates	***	***	72	43
Bars and light structurals				
Hot-finished	218	106	49	40
Cold-finished	187	109	58	59
Pipes and tubes	20	16	80	86
Wire rods	108	71	66	61
Wire	48	32	67	43

[1] Structural shapes with a cross section exceeding 3 inches.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-4
Financial experience of U.S. steel producers and converters,[1] 1990

(In thousands of dollars)

Item	*Integrated*	*Minimills*	*Specialty*	*Processors*
Net sales:				
Excluding intracompany and intercompany transfers	26,421,808	10,728,230	4,520,440	6,217,150
Intracompany and intercompany transfers	1,227,129	945,635	456,513	373,836
Total net sales	27,648,937	11,673,865	4,976,953	6,590,986
Cost of goods sold (including intracompany and intercompany transfers):				
Raw materials	6,452,307	3,607,171	1,795,256	4,015,748
Direct labor	3,485,793	1,044,858	585,761	427,207
Other factory costs, including depreciation and amortization	7,018,894	2,933,487	1,750,869	1,113,057
Total cost of goods sold[2]	25,679,372	10,257,547	4,178,903	5,756,444
Gross profit or (loss)	1,969,565	1,416,309	798,050	834,542
General, selling, and administrative expenses	1,172,803	592,346	339,874	466,003
Net operating profit or (loss)	796,762	823,972	458,176	368,539
Other income or (expense):				
Net interest income or expense	(335,028)	(218,617)	(87,121)	(136,536)
All other income or (expense)[3]	(192,132)	(177,584)	(23,452)	(35,026)
Total other income or (expense)[4]	(527,160)	(396,201)	(110,573)	(171,562)
Net profit or (loss) before taxes	269,602	427,771	347,603	196,977
Depreciation and amortization	1,163,447	433,837	136,963	138,103

[1] Certain respondents included financial information on related products.
[2] Including nonitemized costs.
[3] Certain respondents reported extraordinary and non-recurring expenses.
[4] Including itemized expenses.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-5
Financial experience of U.S. steel producers and converters,[1] January 1, 1991- March 31, 1991

(In thousands of dollars)

Item	*Integrated*	*Minimills*	*Specialty*	*Processors*
Net sales:				
Excluding intracompany and intercompany transfers	5,432,586	2,516,098	1,096,926	1,444,290
Intracompany and intercompany transfers	234,877	251,274	148,965	86,364
Total net sales	5,667,463	2,767,372	1,245,891	1,530,654
Cost of goods sold (including intracompany and intercompany transfers):				
Raw materials	1,352,532	867,713	480,496	930,930
Direct labor	812,611	251,952	140,272	105,504
Other factory costs, including depreciation and amortization	1,752,807	718,870	443,020	287,008
Total cost of goods sold[2]	5,781,421	2,491,290	1,074,017	1,371,814
Gross profit or (loss)	(113,958)	276,082	171,874	158,840
General, selling, and administrative expenses	285,204	148,724	83,099	123,208
Net operating profit or (loss)	(399,162)	127,358	88,775	35,632
Other income or (expense):				
Net interest income or expense	(107,420)	(53,471)	(19,604)	(33,099)
All other income or (expense)[3]	(39,355)	(17,295)	(4,332)	10,168
Total other income or (expense)[4]	(146,775)	(70,766)	(23,936)	(23,077)
Net profit or (loss) before taxes	(545,937)	56,592	64,839	12,555
Depreciation and amortization	281,184	117,459	36,655	48,800

[1] Certain respondents included financial information on related products.
[2] Including nonitemized costs.
[3] Certain respondents reported extraordinary and non-recurring expenses.
[4] Including itemized expenses.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-6
Steel: Total net sales and net profits and losses as a percentage of sales, by selected product, 1990, and Jan. 1, 1991-Mar. 31, 1991

Item	*Total net sales*[1] *1990*	*Total net sales*[1] *Jan.-Mar 1991*	*Net operating profit or (loss) as a percent of sales*[2] *1990*	*Net operating profit or (loss) as a percent of sales*[2] *Jan.-Mar. 1991*
	— Thousand dollars —			
Carbon and certain alloy steel:[3]				
Semifinished	1,480,955	330,688	0.2	(2.4)
Plates	3,152,093	680,987	8.1	1.1
Sheets and strip:				
Hot-rolled	6,546,033	1,431,046	0.3	(11.1)
Cold-rolled	5,942,190	1,162,975	3.3	(7.9)
Galvanized	5,933,180	1,145,937	6.0	(5.3)
Other	4,124,984	976,901	5.3	(3.8)
Subtotal, sheets	22,546,387	4,716,859	3.5	(7.4)
Bars:				
Hot-finished	4,732,563	1,037,101	3.7	(1.0)
Cold-finished	785,444	172,404	2.3	(0.7)
Subtotal, bars	5,518,007	1,209,505	3.5	(1.0)
Wire	947,869	225,025	3.2	0.2
Wire rod	1,478,401	355,862	3.2	0.3
Wire products	982,563	228,076	2.9	(0.4)
Structural shapes and units	2,128,264	493,742	10.1	7.8
Rails and related products	324,357	99,921	(6.2)	0.6
Pipes and tubes:				
Line	857,535	272,082	4.4	4.8
Mechanical	1,244,821	285,485	7.8	5.7
OCTG	821,882	247,487	2.3	2.0
Structural	342,061	82,403	13.5	8.9
Pressure	150,995	35,488	12.9	11.0
Other	919,159	207,129	8.4	5.8
Subtotal, pipes	4,336,453	1,130,074	6.8	5.1
Subtotal, carbon steel	42,895,349	9,470,739	4.3	(2.8)
Stainless and tool steel:				
Semifinished	213,465	58,766	8.3	6.0
Plates	460,258	102,128	12.3	10.9
Sheets and strip	2,254,570	547,991	11.6	8.7
Bars and shapes	820,995	201,475	8.6	6.9
Wire	148,733	33,783	11.6	8.0
Pipes and tubes	135,240	31,405	13.7	11.3
Wire rod	121,143	37,290	1.6	0.8
Subtotal, stainless and tool steel	4,154,404	1,012,838	10.7	8.2
Grand total	47,049,753	10,483,577	4.8	(1.7)

[1] Includes intracompany and intercompany transfers, less discounts, returns, and allowances.
[2] Operating profit is defined as the total net sales, less the cost of goods sold, general, selling and administrative expenses.
[3] Certain alloy refers to alloy steel other than stainless and alloy tool steel.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-7
Carbon steel sheet and strip: Price changes relative to end of 4th quarter 1989, by quarter, as reported by purchasers, 1st quarter 1990 to 1st quarter 1991

Price change (P)	1990 End of 1st quarter	1990 End of 2nd quarter	1990 End of 3rd quarter	1990 End of 4th quarter	1991 End of 1st quarter
	Percent of respondents				
-12.5% ≥ P	1	2	3	4	6
-7.5% ≥ P > -12.5%	2	7	7	8	12
-2.5% ≥ P > -7.5%	17	20	19	21	23
2.5% ≥ P > -2.5%	69	57	52	46	38
7.5% ≥ P > 2.5%	9	12	15	16	16
12.5% ≥ P > 7.5%	0	1	1	3	3
P > 12.5%	1	2	1	2	1

Survey sample:
Number of respondents: 178
Number of price series:[1] 339

[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-8
Carbon steel plate and structurals: Price changes relative to end of 4th quarter 1989, by quarter, as reported by purchasers, 1st quarter 1990 to 1st quarter 1991

Price change (P)	1990 End of 1st quarter	1990 End of 2nd quarter	1990 End of 3rd quarter	1990 End of 4th quarter	1991 End of 1st quarter
	Percent of respondents				
-12.5% ≥ P	0	3	1	4	10
-7.5% ≥ P > -12.5%	3	7	12	10	12
-2.5% ≥ P > -7.5%	16	19	21	24	31
2.5% ≥ P > -2.5%	73	64	55	46	31
7.5% ≥ P > 2.5%	6	6	9	13	12
12.5% ≥ P > 7.5%	0	0	0	1	1
P > 12.5%	1	0	1	0	1

Survey sample:
Number of respondents: 67
Number of price series:[1] 67

[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-9
Carbon steel bars: Price changes relative to end of 4th quarter 1989, by quarter, as reported by purchasers, 1st quarter 1990 to 1st quarter 1991

Price change (P)	1990 End of 1st quarter	1990 End of 2nd quarter	1990 End of 3rd quarter	1990 End of 4th quarter	1991 End of 1st quarter
	Percent of respondents				
-12.5% ≥ P	1	1	2	2	2
-7.5% ≥ P > -12.5%	1	2	2	5	10
-2.5% ≥ P > -7.5%	13	22	22	21	29
2.5% ≥ P > -2.5%	80	63	56	53	44
7.5% ≥ P > 2.5%	4	11	15	13	10
12.5% ≥ P > 7.5%	1	1	1	2	3
P > 12.5	1	1	3	3	3

Survey sample:
Number of respondents: 128
Number of price series:[1] 193

[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-10
Carbon steel wire and wire rod: Price changes relative to end of 4th quarter 1989, by quarter, as reported by purchasers, 1st quarter 1990 to 1st quarter 1991

Price change (P)	1990 End of 1st quarter	1990 End of 2nd quarter	1990 End of 3rd quarter	1990 End of 4th quarter	1991 End of 1st quarter
	Percent of respondents				
-12.5% ≥ P	0	0	0	0	0
-7.5% ≥ P > -12.5%	0	0	0	0	3
-2.5% ≥ P > -7.5%	6	9	16	19	19
2.5% ≥ P > -2.5%	84	78	63	56	47
7.5% ≥ P > 2.5%	9	9	16	13	13
12.5% ≥ P > 7.5%	0	0	3	9	13
P > 12.5%	0	3	3	3	6

Survey sample:
Number of respondents: 27
Number of price series:[1] 32

[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-11
Carbon steelpipe and tube: Price changes relative to end of 4th quarter 1989, by quarter, as reported by purchasers, 1st quarter 1990 to 1st quarter 1991

Price change (P)	1990 End of 1st quarter	1990 End of 2nd quarter	1990 End of 3rd quarter	1990 End of 4th quarter	1991 End of 1st quarter
	Percent of respondents				
-12.5% ≥ P	1	1	2	1	3
-7.5% ≥ P > -12.5%	2	2	4	6	7
-2.5% ≥ P > -7.5%	10	22	27	31	35
2.5% ≥ P > -2.5%	81	63	54	44	31
7.5% ≥ P > 2.5%	6	10	12	17	18
12.5% ≥ P > 7.5%	0	2	1	0	3
P > 12.5%	0	0	1	2	3

Survey sample:
Number of respondents: 79
Number of price series:[1] 117

[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-12
Stainless: Price changes relative to end of 4th quarter 1989, by quarter, as reported by purchasers, 1st quarter 1990 to 1st quarter 1991

Price change (P)	1990 End of 1st quarter	1990 End of 2nd quarter	1990 End of 3rd quarter	1990 End of 4th quarter	1991 End of 1st quarter
	Percent of respondents				
-12.5% ≥ P	0	10	11	14	20
-7.5% ≥ P > -12.5%	4	7	11	14	14
-2.5% ≥ P > -7.5%	15	19	19	19	20
2.5% ≥ P > -2.5%	64	41	41	28	21
7.5% ≥ P > 2.5%	11	12	12	16	16
12.5% ≥ P > 7.5%	1	2	2	5	4
P > 12.5%	1	2	2	4	4

Survey sample:
Number of respondents: 98
Number of price series:[1] 167

[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-13

Carbon steel sheet and strip: Price changes relative to end of 4th quarter 1988, by quarter, as reported by purchasers, 1st quarter 1989 to 1st quarter 1990

	1990				1991
Price change (P)	*End of 1st quarter*	*End of 2nd quarter*	*End of 3rd quarter*	*End of 4th quarter*	*End of 1st quarter*
	Percent of respondents				
-12.5% ≥ P	0	0	1	3	8
-7.5% ≥ P > -12.5%	1	2	5	9	9
-2.5% ≥ P > -7.5%	4	8	12	16	17
2.5% ≥ P > -2.5%	75	59	50	40	36
7.5% ≥ P > 2.5%	17	26	28	28	24
12.5% ≥ P > 7.5%	1	4	4	3	4
P > 12.5%	2	2	2	1	2

Survey sample:
Number of respondents: 178
Number of price series:[1] 343

[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-14

Carbon steel plate and structurals: Price changes relative to end of 4th quarter 1988, by quarter, as reported by purchasers, 1st quarter 1989 to 1st quarter 1990

	1990				1991
Price change (P)	*End of 1st quarter*	*End of 2nd quarter*	*End of 3rd quarter*	*End of 4th quarter*	*End of 1st quarter*
	Percent of respondents				
-12.5% ≥ P	1	2	3	4	11
-7.5% ≥ P > -12.5%	3	1	7	13	18
-2.5% ≥ P > -7.5%	6	10	10	20	20
2.5% ≥ P > -2.5%	73	65	57	41	32
7.5% ≥ P > 2.5%	15	20	19	17	13
12.5% ≥ P > 7.5%	1	2	3	4	3
P > 2.5%	1	1	1	1	2

Survey sample:
Number of respondents: 82
Number of price series:[1] 157

[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-15
Carbon steel bars: Price changes relative to end of 4th quarter 1988, by quarter, as reported by purchasers, 1st quarter 1989 to 1st quarter 1990

Price change (P)	1990 End of 1st quarter	End of 2nd quarter	End of 3rd quarter	End of 4th quarter	1991 End of 1st quarter
	Percent of respondents				
-12.5% ≥ P	0	1	3	3	7
-7.5% ≥ P > -12.5%	1	4	4	10	14
-2.5% ≥ P > -7.5%	5	8	13	16	19
2.5% ≥ P > -2.5%	70	59	52	42	32
7.5% ≥ P > 2.5%	18	21	21	21	21
12.5% ≥ P > 7.5%	4	5	4	3	4
P > 12.5%	2	2	4	4	4

Survey sample:
Number of respondents: 105
Number of price series:[1] 184
[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-16
Carbon steel wire and wire rod: Price changes relative to end of 4th quarter 1988, by quarter, as reported by purchasers, 1st quarter 1989 to 1st quarter 1990

Price change (P)	1990 End of 1st quarter	End of 2nd quarter	End of 3rd quarter	End of 4th quarter	1991 End of 1st quarter
	Percent of respondents				
-12.5% ≥ P	0	1	1	0	1
-7.5% ≥ P > -12.5%	1	1	2	5	3
-2.5% ≥ P > -7.5%	9	3	3	8	16
2.5% ≥ P > -2.5%	78	71	62	53	52
7.5% ≥ P > 2.5%	11	18	23	26	19
12.5% ≥ P > 7.5%	0	4	8	8	5
P > 12.5%	1	1	1	1	3

Survey sample:
Number of respondents: 67
Number of price series:[1] 93
[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-17
Carbon steel pipe and tube: Price changes relative to end of 4th quarter 1988, by quarter, as reported by purchasers, 1st quarter 1989 to 1st quarter 1990

Price change (P)	1990				1991
	End of 1st quarter	*End of 2nd quarter*	*End of 3rd quarter*	*End of 4th quarter*	*End of 1st quarter*
	Percent of respondents				
-12.5% ≥ P	0	0	1	4	4
-7.5% ≥ P > -12.5%	1	3	3	2	7
-2.5% ≥ P > -7.5%	7	4	10	14	18
2.5% ≥ P > -2.5%	77	66	55	50	38
7.5% ≥ P > 2.5%	11	22	26	24	24
12.5% ≥ P > 7.5%	2	3	4	4	7
P > 12.5%	1	1	2	1	1

Survey sample:
Number of respondents: 84
Number of price series:[1] 136

[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-18
Stainless: Price changes relative to end of 4th quarter 1988, by quarter, as reported by purchasers, 1st quarter 1989 to 1st quarter 1990

Price change (P)	1990				1991
	End of 1st quarter	*End of 2nd quarter*	*End of 3rd quarter*	*End of 4th quarter*	*End of 1st quarter*
	Percent of respondents				
-12.5% ≥ P	0	0	3	11	18
-7.5% ≥ P > -12.5%	0	1	8	12	15
-2.5% ≥ P > -7.5%	3	5	19	18	20
2.5% ≥ P > -2.5%	50	42	41	32	25
7.5% ≥ P > 2.5%	14	26	14	19	17
12.5% ≥ P > 7.5%	13	19	10	1	0
P > 12.5%	20	8	6	7	5

Survey sample:
Number of respondents: 82
Number of price series:[1] 146

[1] A number of respondents provided data on more than one product.

Note.—Due to rounding, percentages may not add to 100.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-19
Carbon and certain alloy steel: U.S. producers' and converters' capital expenditures, 1990.

(In thousands of dollars)

Item	*Land and land improvement*	*Plant and equipment*[1] [2]	*Other*	*Total*
Cokemaking facilities	***	***	***	190,316
Ironmaking facilities	***	***	***	372,664
Raw steelmaking facilities:				
Basic oxygen process	***	***	***	126,081
Electric furnace	***	***	***	199,111
Open hearth process	***	***	***	***
Casting	***	***	***	432,185
Secondary steelmaking facilities[3]	***	***	***	115,549
Flat rolled products:				
Plate mills	***	***	***	36,771
Sheets and strip:				
Hot strip mills	***	***	***	429,523
Cold rolled sheet mills	***	***	***	332,840
Galvanizing facilities	***	***	***	460,863
Other coating facilities	***	***	***	73,776
Bar and light structural mills:				
Hot finished	***	***	***	162,679
Cold finished	***	***	***	14,638
Medium and heavy structural mills[4]	***	***	***	***
Rail mills	***	***	***	***
Wire rod mills	***	***	***	4,583
Wire drawing machines	***	***	***	19,497
Wire products	***	***	***	20,606
Pipes and tubes:				
Seamless pipe mills	***	***	***	17,877
Welded pipe mills	***	***	***	49,014
Other pipe and tube mills	***	***	***	27,964
Other[5]	***	***	***	386,658
Total	27,690	3,486,249	96,185	3,610,124

[1] Includes expenditures for the specific type of facility as well as related facilities.
[2] Includes expenditures for pollution control and occupational safety and health (OSH) requirements.
[3] Includes ladle treatment (heat balance, alloy addition, degassing, decarburization, etc.) and other (vacuum arc remelt, electroslag remelting, etc.) secondary refining processes.
[4] Structural shapes with a cross section exceeding 3 inches.
[5] Includes expenditures which companies could not allocate to product groups.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-20
Stainless and alloy tool steel: U.S. producers' and converters' capital expenditures, 1990.

(In thousands of dollars)

Item	*Land and land improvement*	*Plant and equipment*[1 2]	*Other*	*Total*
Raw steelmaking facilities:				
Electric furnace	***	***	***	10,198
Secondary steelmaking facilities[3]	***	***	***	***
Flat rolled products:				
Plate mills	***	***	***	***
Sheets and strip:				
Hot strip mills	***	***	***	***
Cold rolled sheet mills	***	***	***	17,197
Bars and shapes:				
Hot finished	***	***	***	***
Cold finished	***	***	***	***
Wire rod mills	***	***	***	***
Wire drawing machines	***	***	***	2,646
Pipes and tubes:				
Seamless pipe mills	***	***	***	***
Welded pipe mills	***	***	***	***
Other pipe and tube mills	***	***	***	***
Other[4]	***	***	***	***
Total	***	133,320	***	134,274

[1] Includes expenditures for the specific type of facility as well as related facilities.
[2] Includes expenditures for pollution control and occupational safety and health (OSH).
[3] Includes ladle treatment (heat balance, alloy addition, degassing, decarburization, etc.) and other (vacuum arc remelt, electroslag remelting, etc.) secondary refining processes.
[4] Includes expenditures which companies could not allocate to product groups.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-21
Carbon and certain alloy steel: U.S. producers' and converters' capital expenditures, January 1, 1991-March 31, 1991.

(In thousands of dollars)

Item	Land and land improvement	Plant and equipment[1 2]	Other	Total
Cokemaking facilities	***	***	***	63,128
Ironmaking facilities	***	***	***	59,679
Raw steelmaking facilities:				
Basic oxygen process	***	***	***	28,489
Electric furnace	***	***	***	28,886
Open hearth process	***	***	***	***
Casting	***	***	***	***
Secondary steelmaking facilities[3]	***	***	***	***
Flat rolled products:				
Plate mills	***	***	***	***
Sheets and strip:				
Hot strip mills	***	***	***	72,326
Cold rolled sheet mills	***	***	***	***
Galvanizing facilities	***	***	***	***
Other coating facilities	***	***	***	22,479
Bar and light structural mills:				
Hot finished	***	***	***	30,870
Cold finished	***	***	***	2,959
Medium and heavy structural mills[4]	***	***	***	***
Rail mills	***	***	***	***
Wire rod mills	***	***	***	2,818
Wire drawing machines	***	***	***	4,479
Wire products	***	***	***	5,884
Pipes and tubes:				
Seamless pipe mills	***	***	***	3,600
Welded pipe mills	***	***	***	7,309
Other pipe and tube mills	***	***	***	***
Other[5]	***	***	***	54,472
Total	***	719,927	***	744,010

[1] Includes expenditures for the specific type of facility as well as related facilities.
[2] Includes expenditures for pollution control and occupational safety and health (OSH) requirements.
[3] Includes ladle treatment (heat balance, alloy addition, degassing, decarburization, etc.) and other (vacuum arc remelt, electroslag remelting, etc.) secondary refining processes.
[4] Structural shapes with a cross section exceeding 3 inches.
[5] Includes expenditures which companies could not allocate to product groups.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-22
Stainless and alloy tool steel: U.S. producers' and converters' capital expenditures, January 1, 1991-March 31, 1991.

(In thousands of dollars)

Item	*Land and land improvement*	*Plant and equipment*[1] [2]	*Other*	*Total*
Raw steelmaking facilities:				
Electric furnace	***	***	***	***
Secondary steelmaking facilities[3]	***	***	***	***
Flat rolled products:				
Plate mills	***	***	***	***
Sheets and strip:				
Hot strip mills	***	***	***	***
Cold rolled sheet mills	***	***	***	***
Bars and shapes:				
Hot finished	***	***	***	***
Cold finished	***	***	***	***
Wire rod mills	***	***	***	***
Wire drawing machines	***	***	***	***
Pipes and tubes:				
Seamless pipe mills	***	***	***	***
Welded pipe mills	***	***	***	***
Other pipe and tube mills	***	***	***	***
Other[4]	***	***	***	***
Total	***	24,931	***	25,132

[1] Includes expenditures for the specific type of facility as well as related facilities.
[2] Includes expenditures for pollution control and occupational safety and health (OSH).
[3] Includes ladle treatment (heat balance, alloy addition, degassing, decarburization, etc.)and other (vacuum arc remelt, electroslag remelting, etc.) secondary refining processes.
[4] Includes expenditures which companies could not allocate to product groups.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-23
Research and development expenditures during 1990, and Jan.-Mar. 1991, by process and product.

(In thousands of dollars)

Item	1990		Jan.-Mar. 1991	
	Carbon and certain alloy[1]	Stainless and alloy tool	Carbon and certain alloy[1]	Stainless and alloy tool
Cokemaking facilities	5,266	([2])	1,419	([2])
Ironmaking facilities	7,564	([2])	1,554	([2])
Raw steelmaking facilities:				
Basic oxygen process	8,428	([2])	2,309	([2])
Electric furnace	7,751	***	***	***
Other	***	([2])	***	([2])
Seconday steelmaking facilities[3]	***	***	***	***
Flat rolled products:				
Plate mills	***	***	***	***
Sheets and strip;				
Hot strip mills	9,990	***	2,317	***
Cold rolled sheet mills	18,170	***	4,221	***
Galvanizing facilities	17,163	([2])	4,142	([2])
Other coating facilities	10,252	([2])	2,493	([2])
Bar and light structural mills:				
Hot finished	***	***	***	***
Cold finished	***	***	***	***
Medium and heavy structural mills[4]	***	([2])	***	([2])
Rail mills	***	([2])	***	([2])
Wire rod mills	***	***	***	***
Wire drawing machines	***	***	***	***
Wire products	***	***	***	***
Pipes and tubes:				
Seamless pipe mills	***	***	***	***
Welded pipe mills	***	***	***	***
Other pipe and tube mills	***	***	***	***
Other[5]	18,340	***	4,074	***
Total	130,270	***	33,805	***

[1] Certain alloy refers to alloy steel other than stainless and alloy tool steel.
[2] None reported.
[3] Includes ladle treatment (heat balance, alloy addition, degassing, decarburization, etc.) and other (vacuum arc remelt, electroslag remelting, etc.) secondary refining processes.
[4] Structural shapes with a cross section exceeding 3 inches.
[5] Includes expenditures which could not be effectively allocated to product groups.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table J-24
Steel mill products and certain fabricated steel products: U.S. production, by sector

Product/process	Integrated mills	Minimills	Converters	Specialty mills	Total
	Thousand short tons				
Cokemaking	22,617	(1)	(1)	(1)	22,617
Ironmaking	53,825	(1)	(1)	(1)	53,825
Steelmaking:					
Basic oxygen process	57,455	(1)	(1)	***	***
Electric furnace	5,256	28,257	(1)	3,027	36,540
Other	***	(1)	(1)	***	***
Total steelmaking	66,207	28,257	(1)	3,427	97,891
Sheets and strip:					
Hot-rolled	49,590	***	***	908	53,213
Cold-rolled	25,914	***	1,623	***	28,420
Galvanized	9,521	0	1,226	0	10,747
Other coating	4,995	0	***	***	5,589
Plates	3,593	***	***	130	5,245
Bars and light structurals:					
Hot-finished	1,944	12,196	***	***	15,563
Cold-finished	0	873	617	92	1,582
Medium & heavy structurals[2]	***	2,867	***	0	4,511
Pipes and tubes:					
Seamless pipes	***	***	***	***	1,700
Welded pipes	***	1,106	1,962	***	4,067
Other pipe and tube	***	***	250	***	462
Rails and rail products	***	***	0	0	***
Wire rods and derivatives:					
Wire rods	***	3,846	572	***	5,093
Wire	***	1,151	1,362	***	2,619
Wire products	0	637	1,243	0	1,880
	Percent				
Cokemaking	100.0	(1)	(1)	(1)	100.0
Ironmaking	100.0	(1)	(1)	(1)	100.0
Steelmaking:					
Basic oxygen process	***	(1)	(1)	***	100.0
Electric furnace	14.4	77.4	(1)	8.3	100.0
Open hearth process	***	(1)	(1)	***	100.0
Total steelmaking	67.6	28.9	(1)	3.5	100.0
Sheets and strip:					
Hot-rolled	93.2	***	***	1.7	100.0
Cold-rolled	91.2	***	5.7	***	100.0
Galvanized	88.6	0.0	11.4	0.0	100.0
Other coating	89.4	0.0	***	***	100.0
Plates	68.5	***	***	2.5	100.0
Bars and light structurals:					
Hot-finished	12.5	78.4	***	***	100.0
Cold-finished	0.0	55.2	39.0	5.8	100.0
Medium & heavy structurals[2]	***	63.6	***	0.0	100.0
Pipes and tubes:					
Seamless pipes	***	***	***	***	100.0
Welded pipes	***	27.2	48.2	***	100.0
Other pipe and tube	***	***	54.1	***	100.0
Rails and rail products	***	***	0.0	0.0	100.0
Wire rods and derivatives:					
Wire rods	***	75.5	11.2	***	100.0
Wire	***	43.9	52.0	***	100.0
Wire products	0.0	33.9	66.1	0.0	100.0

[1] Not applicable.
[2] Structural shapes with a cross section exceeding 3 inches.

Note.—Totals may not add to 100 percent because of rounding.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

APPENDIX K
MAJOR COMPANY CASH FLOW

Table K-1
Calculation of major companies' net income from steel product operations, October 1, 1990-May 31, 1991
(In thousand dollars)

Item	Calculation
Net sales	13,838,806
Cost of goods sold	13,586,955
General, selling, and administrative expenses	799,711
Interest expense	311,511
Reserves, provisions, special charges and other unusual items	[1]1,241,875
All other expenses or (income)	(217,413)
Current income taxes	(219,879)
Tax effect of operating loss carry forward	(16,881)
Investment tax credit refund	0
Deferred taxes	1,714
Net income from steel operations	(1,648,787)

[1] Includes restructuring expenses of * * *.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table K-2
Sources and uses of cash and cash equivalents in steel product operations, October 1, 1990-May 31, 1991
(In thousand dollars)

Item	Calculation
Cash provided from (cash used in) operations:	
Net income[1]	(1,648,787)
Depreciation, depletion, and amortization	695,595
Noncash income tax expense	3,873
Noncash charges (credits):	
Relating to reserves, provisions, special charges and other unusual items	834,938
Other	316,264
Cash flow from earnings	201,883
Changes in working capital, excluding financing activities	(322,112)
Cash flow from operations	(120,229)
Cash provided from (used in) financing activities:	
Net additions to or (reductions) in long and short term debt	450,724
Changes in capital stock	(17,708)
Transfers from or (to) corporate	715,925
Other	(524,770)
Subtotal	624,171
Investment,[2] dividends paid, and other cash provided (used)	(1,524,007)
Increase (decrease) in cash and cash equivalents	(1,020,065)
Cash and cash equivalents:	
Beginning of period[3]	1,008,865
End of period[3]	(11,200)

[1] Includes restructuring expenses of * * *.
[2] Includes capital expenditures and cash generated from disposal of assets.
[3] * * * were unable to provide figures for the beginning and end of period for their steel product operations, but did provide the net change in cash and cash equivalent over the period.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table K-3
Calculation of major companies' cash flow on steel product operations,[1] Oct. 1, 1990-May 31, 1991

(In thousand dollars)

Item	*Calculation*
Cash flow from earnings	201,883
Net changes in long and short term debt and liabilities[2]	[3]128,612
Dividends paid	(55,315)
Net cash flow from steel product operations[4]	[5]146,568

[1] Under P.L. 98-573, section 806 (b)(2)(B) net cash flow is defined as "annual net (after-tax) income plus depreciation, depletion allowances, amortization, and changes in reserves minus dividends and payments on short-term and long-term debt and liabilities." The Conference report on the bill states that payment on short and long-term debt and other liabilities means the net reduction in such debt and liabilities.

[2] Includes net changes in working capital.

[3] Calculated by summing net changes for all companies, including positive changes of $1,113.7 million and negative changes $985.1 million.

[4] Including net income pertaining to prior periods, exclusion of which would reduce cash flow to $130.3 million.

[5] Since the net change in long and short term debt was positive, there was no "net reduction in short and long term liabilities". Net cash flow was therefore calculated as the sum of cash flow from earnings, minus dividends.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table K-4
Major U.S. steel companies: Net cash flow from steel product operations, and steel-related expenditures, by company, Oct. 1, 1990–May 31, 1991

(In thousand dollars)

		Steel related expenditures									
Company	Net cash flow [1] (1)	Plant and equipment (2)	Research and development (3)	Retraining workers [2] (4)	Other (5)	Total expenditures (6)	Expenditures reflected in net cash flow (7)	Net expenditures (6–7) (8)	Net increases in debts and liabilities (9)	Adjusted net cash flow (1+4–9) (10)	Expenditures for retraining workers as a percent of adjusted net cash flow (11)
Armco											
Bethlehem											
Inland											
LTV											
National											
Rouge											
USX											
Weirton											
Wheeling–Pittsburgh											
Total	[9] 275,180	1,551,039	82,142	63,805	24,884	1,721,870	168,876	1,552,994	499,612	(160,627)	([3])

[1] Including income pertaining to prior periods and net increases in short and long term debt and liabilities.
[2] Included as expenses in net income calculations.
[3] Not applicable; negative cash flow.
[4] • • •
[5] • • •
[6] • • •
[7] • • •
[8] • • •
[9] Includes net increases in short term debt and liabilities of $128,612,000.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table K-5
Major U.S. steel companies: Net cash flow from steel product operations, and steel-related expenditures, by company, June 1, 1991–September 30, 1991 (estimate)

(In thousand dollars)

Company	Net cash flow [1] (1)	Steel related expenditures: Plant and equipment (2)	Research and development (3)	Retraining workers [2] (4)	Other (5)	Total expenditures (6)	Expenditures reflected in net cash flow (7)	Net expenditures (6–7) (8)	Net increases in debts and liabilities (9)	Adjusted net cash flow (1+4–9) (10)	Expenditures for retraining workers as a percent of adjusted net cash flow (11)
Armco											
Bethlehem											
Inland											
LTV											
National				*		*	*				
Rouge											
USX											
Weirton											
Wheeling–Pittsburgh											
Total	52,256	720,575	65,310	25,941	69,469	881,295	91,251	790,044	([3])	78,197	33.2

[1] Included as expenses in net income calculations.
[2] Estimated assuming funds used for research and development and for worker retraining will be reflected in net cash flow.
[3] Not available.
[4] * * *

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table K-6
Calculation of major companies' net income from steel product operations, Oct. 1, 1989-Sep. 30, 1990

(In thousand dollars)

Item	*Calculation*
Net sales	23,349,344
Cost of goods sold	21,254,895
General, selling, and administrative expenses	1,239,750
Interest expense	394,812
Reserves, provisions, special charges and other unusual items	(41,898)
All other expenses or (income)	(74,831)
Current income taxes	183,188
Tax effect of operating loss carry forward	(115,166)
Investment tax credit refund	0
Deferred taxes	(3,827)
Net income from steel operations	512,421

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table K-7
Sources and uses of cash and cash equivalents in steel product operations, October 1, 1989-September 30, 1990

(In thousand dollars)

Item	*Calculation*
Cash provided from (cash used in) operations:	
Net income	512,421
Depreciation, depletion, and amortization	1,115,073
Noncash income tax expense	(1,904)
Noncash charges (credits):	
Relating to reserves, provisions, special charges and other unusual items	(73,661)
Other	122,402
Cash flow from earnings	1,674,331
Changes in working capital, excluding financing activities	(28,323)
Cash flow from operations	1,646,008
Cash provided from (used in) financing activities:	
Net additions to or (reductions) in long and short term debt	45,042
Changes in capital stock	5,863
Transfers from or (to) corporate	300,556
Other	177,399
Subtotal	528,860
Investment,[1] dividends paid, and other cash provided (used)	(2,272,929)
Increase (decrease) in cash and cash equivalents	(98,061)
Cash and cash equivalents:	
Beginning of period[2]	1,106,925
End of period[2]	1,008,864

[1] Includes capital expenditures and cash generated from the disposal of assets.
[2] Does not include data of * * *.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table K-8
Calculation of major companies' cash flow on steel product operation,[1] Oct. 1, 1989-Sep. 30, 1990

(In thousand dollars)

Item	*Calculation*
Cash flow from earnings	1,674,331
Net changes in long and short term debt and liabilities[2]	[3]16,719
Dividends paid	(124,654)
Net cash flow from steel product operations	1,549,677

[1] Under P.L. 98-573, section 806 (b)(2)(B) net cash flow is defined as "annual net (after-tax) income plus depreciation, depletion allowances, amortization, and changes in reserves minus dividends and payments on short-term and long-term debt and liabilities." The Conference report on the bill states that payment on short and long-term debt and other liabilities means the net reduction in such debt and liabilities.

[2] Includes net changes in working capital.

[3] Including net income pertaining to prior periods and net increases in short-term and long-term debt and liabilities, exclusion of which would reduce cash flow to $232.2 million.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table K-9
Major U.S. steel companies: Net cash flow from steel product operations, October 1, 1989,-September 30, 1990

(In thousand dollars)

	Net cash flow[1]	*Net income (loss) pertaining to prior period*	*Net increase in short and long term debt and liabilities[2]*
Armco	*	*	*
Bethlehem			
Inland			
LTV			
National			
Rouge			
USX			
Weirton			
Wheeling-Pittsburgh			
Total	1,566,396	104,466	408,749

[1] Including net income pertaining to prior periods and net increases in long and short debt and liabilities

[2] Includes net changes in working capital.

3 * * *

4 * * *

5 * * *

6 * * *

7 * * *

8 * * *

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table K-10
Major U.S. steel companies: Net cash flow from steel product operations, and steel-related expenditures, by company, Oct. 1, 1989-September 30, 1990

(In thousand dollars)

		Steel related expenditures									
Company	Net cash flow [1] (1)	Plant and equipment (2)	Research and development (3)	Retraining workers [2] (4)	Other (5)	Total expenditures (6)	Expenditures reflected in net cash flow (7)	Net expenditures (6–7) (8)	Net increases in debts and liabilities (9)	Adjusted net cash flow (1+4–9) (10)	Expenditures for retraining workers as a percent of adjusted net cash flow (11)
Armco											
Bethlehem											
Inland											
LTV											
National											
Rouge											
USX											
Weirton											
Wheeling-Pittsburgh											
Total	[4]1,566,396	2,111,953	112,676	81,431	27,950	2,334,010	212,819	2,121,191	408,749	1,239,078	6.6

[1] Included as expenses in net income calculations.
[2] Estimated assuming funds used for research and development and for worker retraining will be reflected in net cash flow.
[3] Not applicable: net decrease.
[4] Includes net increases in short term and long term debt and liabilities of $45,042,000.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

APPENDIX L
MAJOR COMPANY ACTIONS TO MAINTAIN INTERNATIONAL COMPETITIVENESS

Table L-1
Actions by Armco Steel Company, LP to maintain international competitiveness

Plant location	*Type of operation*	*Details*
Middletown, Ohio	COATING	Constructing Gravitel-type electrogalvanizing line (290,000 tons/year) for zinc and zinc-nickel coated products. Upgrading the No. 4 continuous strip pickling line that involves new granite-link tanks, loopers, and a tension levelling scalebreaker.
	ROLLING	Upgrading the 86" hot strip mill by including the application of pair cross mill and on-line roll grinder technology on four finishing stands, hydraulic automatic gage control on three stands and the conversion of two reheat furnaces from pusher to walking beam type.
Ashland, Kentucky	STEELMAKING	Converted bloom caster to a 66" x 9.5" single-strand slab machine.

Source: Based on company submissions, discussions with company executives, and secondary sources (including Charles J. Labee and Norman L. Samways, "Developments in the Iron and Steel Industry U.S. and Canada-1990," *Iron and Steel Engineer*, February 1991).

Table L-2
Actions by Bethlehem Steel Corporation to maintain international competitiveness

Plant location	*Type of operation*	*Details*
Chesterton, Indiana	STEELMAKING	Relining D blast furnace.
		Completed construction of vacuum degasser. Replacing No. 2 BOF vessel and trunnion ring. Adding hydraulic gage control finishing stand to 160" plate mill.
	ROLLING	Adding a process control computer to the 160" plate mill.
	COATING	Adding a hot dipped galvanizing line.
	ENVIRONMENT	Adding a coke-oven benzene emission control.
Sparrows Point, Maryland	STEELMAKING	Relined L blast furnace. Reopened J and H furnaces. Improved caster by adding high-speed width changing capability.
	ROLLING	Completed 48" tandem mill. Modernizing the 68" hot strip mill including: reheat furnaces, reversing rougher, vertical edger, crop shear, Coilbox, coilers and coil handling facilities.
	COATING	Improved the No. 3 pickling line. Installing a new coating line for galvanized and Galvalume sheet products.
	ENERGY USE	Restarting coal chemical plant.
	ENVIRONMENT	Reduced toxicity of coke-oven emissions.
Bethlehem, Pennsylvania	ENVIRONMENT	Reduced toxicity of coke-oven emissions.
Johnstown, Pennsylvania	STEELMAKING	Completed a ladle reheating facility.
Lackawanna, New York	ENVIRONMENT	Installed pollution control on coke batteries.

Source: Based on company submissions, discussions with company executives, and secondary sources (including Charles J. Labee and Norman L. Samways, "Developments in the Iron and Steel Industry U.S. and Canada-1990," *Iron and Steel Engineer*, February 1991).

Table L-3
Actions by Inland Steel Company to maintain international competitiveness

Plant location	*Type of operation*	*Details*
East Chicago, Indiana	STEELMAKING	Started lining and upgrading No. 5 blast furnace; to include improvements to bosh, stockhouse and cast-house, hot blast system and gas cleaning. Rebuilt No. 1 slab caster. Upgraded RH-OB vacuum degasser. Added a ladle metallurgy facility to the No. 1 electric furnace and billet caster. Upgrading the No. 1 billet caster.
	ROLLING	Adding two new roll grinders and rebuilding one on the Nos. 4 and 5 roll shops. Added a new No. 2 hot bed to the 21" bar mill. Working on a controlled cooling facility and a speed control upgrade for the 21" bar mill. Commissioned a walking beam furnace; completed a double expand downcoiler mandrel with outboard bearings, adding a new coiler width gage, a new hot band ship facility, and a R5 width gage for the 80" hot strip mill. Constructing delay table covers, hydraulic automatic gage control, work roll benders, electric loopers, interstand cooling equipment, shapemeter, profilemeter, vamp, elastomeric couplings on finishing mills, and coiler speed control. Revamping hot runout table.
	COATING	Improving entry end and in-line temper mill on the No. 5 galvanizing line. Added rubber sleeves; adding inspection line rubber sleeves to the 29 temper mill. Upgrading hydraulic automatic gage control on the 80" tandem mill. Modifying the supply and loadout station and completed the acid and waste pickle liquor for the Nos. 4 and 5 pickle line dry heat. Added double-stand loop car for the No. 3 continuous galvanizing line.
	ENVIRONMENT	Upgrading the No. 4 BOF hoods and scrubbers. Controlling benzene sources at the Plant 2 coke and No. 11 coke-oven battery. Desulfurizing the Plant 2 coke-oven gas. Adding rinse water elementary neutralization for the pickle lines. Adding casthouse emissions control to the No. 7 blast furnace.
New Carlisle, Indiana	COATING	Installing a 500,000 tons/year hot dip galvanizing and 400,000 tons/year Gravitel electrogalvanizing line for the production of Zinc and Zinc-Nickel coated products.

Source: Based on company submissions, discussions with company executives, and secondary sources (including Charles J. Labee and Norman L. Samways, "Developments in the Iron and Steel Industry U.S. and Canada-1990," *Iron and Steel Engineer*, February 1991).

Table L-4
Actions by LTV Steel Company to maintain international competitiveness

Plant location	*Type of operation*	*Details*
Cleveland, Ohio	STEELMAKING	Constructing a 280 ton vacuum degassing facility. Constructing a 2 million ton/year continuous slab caster. Installed a ladle reheating facility. Upgraded C-5 furnace.
	COATING	Constructed a 900,000 tons/year continuous annealing line including a double-sided laser-based surface inspection system.
	ENVIRONMENT	Reduced toxicity of coke-oven emissions.
Hennepin, Illinois	ROLLING	Installing an advanced flatness control system on the 5-stand tandem mill that includes hydraulic equipment, coolant sprays, shapemeter, transverse strip temperature sensing and computer control equipment.

Source: Based on company submissions, discussions with company executives, and secondary sources (including Charles J. Labee and Norman L. Samways, "Developments in the Iron and Steel Industry U.S. and Canada-1990," *Iron and Steel Engineer*, February 1991).

Table L-5
Actions by National Steel Corporation to maintain international competitiveness

Plant location	*Type of operation*	*Details*
Granite City, Illinois	STEELMAKING	Completed 80.4" single strand with variable width mold for the continuous caster. Relining B blast furnace.
	ROLLING	Installed hydraulic automatic gage control and thickness gages and upgraded electrical system on the tandem mill. Making improvements on the reheat furnace, rehabilitating the runout table and hydraulic automatic gage control, upgrading electrical controls on the 80" hot strip mill.
	ENVIRONMENT	Improving controls on benzene emissions.
Ecorse, Michigan	STEELMAKING	Rebuilding the No. 5 coke battery. Installed a twin snorkel and relining D blast furnace on the vacuum degasser.
	ROLLING	Installing roll bending capability, replacing speed regulator, setting up computers on the tandem mill. Installing a three stand hydraulic automatic gage control, installing roll bending capability, upgrading the loopers/speed regulators, and adding new rectifiers/transformers on the 80" hot strip mill.
	COATING	Refitted the 72" electrogalvanizing line by converting to insoluble anodes.
	ENERGY USE	Installed a new internal natural gas distribution system.
Portage, Indiana	ROLLING	Installing hydraulic automatic gage control and closed-loop shape control on the 80" tandem mill. Modernizing with hydraulic automatic gage control, speed regulators, and entry X-ray on the 52" tandem mill. Undergoing ongoing enhancements for process control.
	COATING	Improving the cooling capacity, hold zone, and modernizing the electrical control on the 72" galvanizing line.

Source: Based on company submissions, discussions with company executives, and secondary sources (including Charles J. Labee and Norman L. Samways, "Developments in the Iron and Steel Industry U.S. and Canada-1990," *Iron and Steel Engineer*, February 1991).

Table L-6
Actions by Rouge Steel Company to maintain international competitiveness

Plant location	*Type of operation*	*Details*
Dearborn, Michigan	STEELMAKING	Replacing all stack and bottom refractories on the C blast furnace. Installing new skip-hoist controls and motors. Installing new hot blast main, bustle pipe. Demolished existing C-4 hot blast stove and installed new C-4 Maxistove. Converting BOF to mobile carrier slag removal. Increasing slag pot capacity at BOF vessels, EAF, and continuous caster. Installed replacement B vessel at BOF with new trunnion ring and bearings with provisions for future bottom stirring. Installed equipment to initiate foamy slag practice consisting of O and C lance manipulator with vertical lift capability, temperature/sample probe manipulator and C injection system for the EAF. Installing bottom-poured ingot capability of 3,600 tons/month replacing equivalent quantity of top-poured ingots.
	ROLLING	Computerizing finishing mill by installing new automation systems to improve gage, width, and temperature control by replacing or modifying existing electrical systems, and mechanical modifications to runout table system. Installing supervisory control for slab reheat furnaces at hot strip mill. Providing additional functionality and support for finish mill automation and furnace supervisory.computer systems. Installing automatic work roll changers consisting of new side-shifting roll change cars at each stand of No. 2 tandem cold mill capable of changing rolls with strip in the mill. Installing quick-open shims on stands 2, 3, and 4. Modifying tandem mill chocks to suit new system.
	COATING	Installed new annealing equipment utilizing all Hydrogen atmosphere capable of processing 150,000 tons/ year. Installed new coil transport system to bring coils to new annealing shop and to remove coils to temper mill area.

Source: Based on company submissions, discussions with company executives, and secondary sources (including Charles J. Labee and Norman L. Samways, "Developments in the Iron and Steel Industry U.S. and Canada-1990," *Iron and Steel Engineer*, February 1991).

Table L-7
Actions by United States Steel Corporation to maintain international competitiveness

Plant location	*Type of operation*	*Details*
Clairton, Pennsylvania	STEELMAKING	Adding primary coolers.
Fairfield, Alabama	STEELMAKING	Added a top blowing lance to the Q-BOP furnaces.
	ROLLING	Made improvements on the 52" 6-stand cold rolling mill.
Fairless Hills, Pennsylvania	ROLLING	Upgraded the hot strip mill coiler.
	COATING	Upgraded the No. 2 continuous annealing line.
Gary, Indiana	STEELMAKING	Relined No. 4 blast furnace. Relining No. 13 blast furnace. Upgrading No. 3 continuous slab caster. Upgrading No. 1 BOP shop heat size.
	ROLLING	Modernized 84" hot strip mill roll grinders. Modernized tin mill roll shop facilities.
Braddock, Pennsylvania	ROLLING	Adding hydraulic gage control for 160" plate mill.
Leipsic, Ohio	COATING	Adding new hot dip galvanizing line.

Source: Based on company submissions, discussions with company executives, and secondary sources (including Charles J. Labee and Norman L. Samways, "Developments in the Iron and Steel Industry U.S. and Canada-1990," *Iron and Steel Engineer*, February 1991).

Table L-8
Actions by Weirton Steel Corporation to maintain international competitiveness

Plant location	*Type of operation*	*Details*
Weirton, West Virginia	STEELMAKING	Replacing. No. 7 BOP vessel. Adding external de-sulfurization of hot metal, BOP bottom stirring, and RH degasser. Upgraded continuous caster. Engineering for sublance. Engineering for CAS OB. Rebuilding No. 1 blast furnace.
	ROLLING	Reversing roughing mill, adding slab sizing press, additional finishing stand, new crop shear, new down-coilers and mill automation for hot mill. Modernizing No. 3 continuous pickler. Upgrading No. 5 continuous pickler. Adding two walking beam slab reheat furnaces.
	COATING	Rebuilding Weirzin plater. Adding X-ray gages for Nos. 2 and 4 plater. Adding tension levelling and surface conditioning unit for galvanized products. Upgrading No. 5 galvanize line. Engineering for No. 1 continuous anneal. Upgrading hydrogen anneal in strip steel.
	ENVIRONMENT	Upgraded A and B boiler house scrubber system. Launching NPDES water pollution abatement program for tin mill and de-tinning plant. Launched outfall elementary waste neutralization program.

Source: Based on company submissions, discussions with company executives, and secondary sources (including Charles J. Labee and Norman L. Samways, "Developments in the Iron and Steel Industry U.S. and Canada-1990," *Iron and Steel Engineer*, February 1991).

Table L-9
Actions by Wheeling-Pittsburgh Corporation to maintain international competitiveness

Plant location	*Type of operation*	*Details*
Allenport, Pennsylvania	ROLLING	Adding automatic gage control/shape control for tandem mill.
	ENVIRONMENT	Adding wastewater treatment system for tandem mill. Adding pickle liquor acid storage system and hydrochloric acid tank.
Canfield, Ohio	ENVIRONMENT	Installed ventilation and fume scrubber system.
Follansbee, West Virginia	ENVIRONMENT	Reduced benzene and sulfur emissions at coke and by-products plant.
Martins Ferry, Ohio	COATING	Added air wipe system for 36", 48", and 60" continuous galvanizing lines. Added zinc coating control system for 36" and 48" galvanizing line. Adding new tension levelers for 48" and 60" galvanizing lines. Installing Galfan production equipment for 48" galvanizing line. Added zinc coating control system for electrostatic oiler on 60" galvanizing line.
	ENVIRONMENT	Installed fume collection baghouse for 36", 48", and 60" galvanizing line.
Steubenville, Ohio	STEELMAKING	Relining No. 1 blast furnace for blast furnace.
	COATING	Added No. 3 pickler electrostatic oiler for finishing.
	ENVIRONMENT	Added additional wastewater treatment facility to blast furnace.
Mingo Junction, Ohio	STEELMAKING	Adding oxygen enrichment for No. 3 blast furnace. Added new scrap transfer car system, bottom stirring, two new oxygen lance handling cranes, new top cone assembly-B vessel, LMF Phase I chemical reheat for BOF. Replacing A vessel for BOF. Added breakout detection system on caster.
	ROLLING	Added alternate fuel burners, reheat furnaces, replacing mill table Phase I and II, replacing 60" roll grinder, installed R3 roughing mill for 80" hot strip mill. Added computer control system for slab reheat furnaces. Added dual camera width gage.
	ENVIRONMENT	Added wastewater treatment system and adding gas flare stack system for Nos. 3 and 5 blast furnaces. Added wastewater treatment system for 80" hot strip mill. Added slab storage and handling facilities. Added wastewater treatment system for boilerhouse.
Yorkville, OH	COATING	Added coating thickness gage for No. 1 tin line. Added computer control system for batch annealing. Replacing electrical control system for pickler. Added electrical controls for screwdown drives on tandem mill. Adding deionizing equipment for No. 7 strip cleaning line.

Source: Based on company submissions, discussions with company executives, and secondary sources (including Charles J. Labee and Norman L. Samways, "Developments in the Iron and Steel Industry U.S. and Canada-1990," *Iron and Steel Engineer*, February 1991).